THE PERCEIVED NEED AND USAGE OF PROJECT MANAGEMENT CONTROL DURING THE IMPLEMENTATION OF SYSTEM DEVELOPMENT METHODOLOGIES

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ABSTRACT

Organizations are faced with mounting demands for complex software applications. Consequently, information systems departments can ill afford development environments that are unstructured, lack monitoring, and control. Use of a system development methodology (SDM) is a fundamental means for a software development organization to provide a consistent, repeatable process to develop and control application projects. However, the majority of organizations fail to successfully implement an SDM. One recommended practice to overcome these implementation failures is the use of project management (PM). The purpose of this study is twofold. First, PM practices deemed important for successful SDM implementation are identified. This is accomplished through in-depth personal interviews with twelve experts and analysis of survey responses from 192 SDM implementation participants within 61 companies. Second, the gap between these recognized practices and practices actually used in SMD implementation are quantified and examined. In conclusion, possible reasons for the gap are presented with suggestions for future research.

INTRODUCTION

The necessity for large, complex information applications in business has escalated to unprecedented levels. This demand, coupled with today's rapid advances in technology, has created a disastrous amalgam for information technology (IT) organizations. As a result, a majority of corporate IT projects are canceled, overbudget or late. Failure to deliver required software in a timely manner is costing organizations hundreds of billions of dollars [2,10].

To overcome the delays and escalating development costs, organizations are paying more attention to their business processes. Many development processes are built around a formal system development methodology (SDM). SDMs are logically appealing. They offer a framework for the sequence of tasks needed to develop an application, as well as tools and techniques used to

accomplish these tasks. SDMs create an engineering-like development discipline that is intended to provide explicit deliverables and consistency throughout the many phases of system development [6]

Unfortunately, the majority of IS organizations fail to successfully implement and utilize a systems development methodology. Thus, developers resort to previous unstructured and possibly chaotic approaches. An indication of this is found using the capability maturity model. Studies conducted by Carnegie Mellon's Software Engineering Institute suggest that approximately 70 to 75 percent of the IS organizations evaluated are at the lowest level of maturity, labeled initial or chaotic [14,15]. At this level organizations develop applications without formal controls offered by standard processes. Why do so many organizations fail at implementing and adopting a systems development methodology? One possible answer is lack of formal implementation monitoring and control. Project management (PM) principles provide an avenue for structured implementation of complex projects and are applicable to SDM implementation [4,11].

The purpose of this study is twofold. First, PM practices deemed important for successful SDM implementation are identified. This is accomplished by in-depth personal interviews with twelve experts as well as analysis of responses from survey participants. Second, the gap between these recognized practices and actual implementation practices is quantified and examined. Potential reasons for the gap are also explored.

The following section presents information on systems development methodologies. A discussion of SDM implementation challenges and project management principles follows. Next, the methodology used to examine SDM and PM practices is presented. Lastly, the research findings and their potential implications are discussed.

SYSTEM DEVELOPMENT METHODOLOGIES

Systems development methodologies have been in existence for over forty years. The basic concept underlying system development methodologies is that there is a well-defined process through which a system can be designed, developed, and implemented. A methodology is "a systematic approach to conducting at least one complete phase (e.g. design; testing) of software production, consisting of a set of guidelines, activities, techniques and tools, based on a particular philosophy of system development and the target system [17, pg. 182]." It can include step-by-step activities for each phase, roles and responsibilities for the project team and important stakeholders, tools and techniques available to execute the tasks and activities, and the deliverables that are developed within the phases, tasks and activities.

Systems development methodologies offer several advantages to an IT organization. First, a methodology can reduce the risk associated with missing important tasks and deliverables. The tasks necessary to develop deliverables are defined within the SDM, minimizing if not eliminating overlooked tasks in the systems development process. Missing tasks and deliverables is not only costly in terms of rework and missed contractual obligations but can have an adverse impact on customer satisfaction. Second, the detailed framework offered within a methodology assists in management control. Since an SDM specifies the task sequence and project deliverables, the project manager can analyze how a delay in one task will impact the overall phase or project. Third, communication and coordination can be enhanced using an SDM by providing a consistent set of deliverables, standard conventions, formats and approach to systems development. Fourth, a methodology generally includes tools that assist in efficient and effective use of resources and ensure that quality is infused within the process. Finally, an SDM increases the likelihood that significant errors can be detected early in the development process and reduce wasted effort in the development of poorly defined requirements [16, 18].

Typically, an SDM includes some version of the following phases [10, 18]:

1. *Systems feasibility* evaluates the strategic fit of the system, analyzes the business and technical problem domains and evaluates the technical, operational, economic, and schedule feasibility of the project.

2. *Systems analysis* identifies and analyzes the business functions to be included and excluded, the overall information requirements, interfaces to other systems, performance objectives, as well as audit and control requirements.
3. *Systems design* defines the external behavior of the system via graphical user interfaces, reports, and processes as well as the hardware, databases, networks, and programs for the system.
4. *Systems implementation* involves developing or acquiring, then testing the hardware, databases, networks, and programs.
5. *Installation* identifies the final steps needed to place the system into daily operation such as conversion, training and client support. Most modern methodologies incorporate the use of a myriad of tools and techniques for performing the tasks and activities within the SDM. These include modern structured analysis and design techniques, data modeling, prototyping, joint application design, rapid application design, and object-oriented analysis and design [16].

THE CHALLENGE: IMPLEMENTATION OF AN SDM

Implementing a systems development methodology is a significant undertaking for most IT organizations. Efforts to achieve major improvements in application development performance often require changing business processes and procedures, work and management styles, job descriptions, roles and responsibilities, and the introduction of new technologies and techniques. Changing the existing norms and work habits surrounding the development delivery methods that have been institutionalized can be extremely difficult requiring a significant investment in resources. Formal project management is recommended for efforts bearing such complexity and difficulty as implementing an SDM [5, 6].

Project management is "the application of knowledge, skills, tools and techniques to project activities so as to meet or exceed stakeholder needs and expectations" [pg.7, 5]. The project management process can be organized into five subprocesses.

Table 1 Project Management Processes Defined within the Project Management Institute's Project Management Body of Knowledge

Initiating	recognizing that a project or phase should begin and committing to do so.
Planning	devising and maintaining a workable scheme to accomplish the business need addressed by the project.
Executing	coordinating people and other resources to carry out the plan.
Controlling	ensuring that project objectives are met by monitoring and measuring progress and taking corrective action when necessary.
Closing	formalizing acceptance of the project or phase and bringing it to an orderly end.

[5, pg. 28]

Applying formal project management principles to complex projects such as implementing an SDM could prove extremely beneficial. These processes promote: (1) adequate definition of the scope of the project, (2) defined project tasks and assigned resources accountable for task completion and quality of the deliverables, (3) organization and coordination of the project effort, (4) management and control of the implementation project, and (5) formal acceptance of the project being complete. Importantly, project management can also assist in assuring adequate communication between the various project stakeholders and managing their divergent expectations. Managing and influencing stakeholders whose interests will be affected by the execution and completion of the project is paramount to the successful implementation of an SDM [5,16].

THE STUDY

Methodology

A two-phased research approach was taken to first, determine important PM processes in SDM implementation, second, evaluate the perceived need of PM processes in SDM implementation and third, explore the extent of use of project management practices in the implementation of SDMs. The first segment of the research focused on project management components perceived to be integral components for successful SDM implementation. A literature review of project management and process implementation was used as the foundation for developing structured interview questions. To confirm the importance of these PM components, twelve SDM experts noted in the IS literature were

selected for interviews. To gain a broad perspective and enhance validity, the experts included both internal systems personnel and external consultants. Table 2 presents names of the experts interviewed and their affiliations when the interviews were completed.

The interview questions were open-ended to avoid leading the experts in any responses or direction. The interviews, conducted in person or by telephone, followed a structured interview guide. Conversations were taped and transcribed to assure complete reconstruction of answers to each question. A content analysis was performed on each interview transcript, then again across each interview question. The results of the content analysis were compiled and collectively examined to identify project management practices that were raised in the interviews. A PM practice had to be specifically mentioned by at least 8 of the 12 participating experts to be considered an integral component for successful SDM implementation. The personal interviews resulted in the identification of twenty-two integral components of project management applicable to systems development methodologies. The information collected from the interviews was used to complete the second phase of the research.

Table 2: Expert Panelists

EXPERT	AFFILIATION
Ed Yourdon	Yourdon & Associates Consultant, Author, Methodologist
Garland Flavorito	Consultant
Ken Orr	Ken Orr & Associates Consultant, Author, Methodologist
Vaughan Merlyn	Ernst & Young Consulting Partner, Author
Dr. Sami Albanna	Yourdon & Associates
Donna Wicks	Consultant
Mike Rice	Coopers & Lybrand Managing Associate
Dennis Mi nnium	Texas Instruments IEF DEVELOPER
John Riley	Texas Instruments National Consulting Practices Manager, IEF
Rick Bastidas	Consultant
Susan Ball	Interactive Development Environments Director, Educational and Consulting Services
Mariann Manzi	Dun & Bradstreet Software Software Developer Manager

The twenty-two PM practices identified as important aspects for successful SDM implementation were used to develop a questionnaire. These practices, categorized under Initiation and Planning, Execution and Control, and Closing are found in Table 6. Constituents were asked for two responses on each item. The first response concerned the extent to which a particular PM practice ***contributes*** to implementing the SDM within their organization. The second response concerned the extent to which the specific practice ***should contribute*** to implementing a SDM. Items were measured using a six-point Likert scale ranging from 1 (not at all) to 6 (very great extent). Questionnaire items are discussed below.

Initiation and Planning Initiation and planning are key processes within project management. These subprocesses set a foundation of organizational commitment, identify the resources needed for the project, and define the direction and required tasks to complete the project [5]. Seven questions were asked concerning project initiation and planning of the SDM implementation. The first three survey items address commitment to the project. As already discussed, implementation of an SDM can bring difficult changes to an IS organization that mandate management support and commitment to resources. Commitment to IS projects can influence the eventual success of the project [13]. A recent 4-year, 1.5 million dollar research project at Boston University found heavy managerial involvement as the most important enabler and predictor of success within systems projects [10]. Executive management as well as both functional managers and IS managers must be willing to commit the necessary skilled and qualified personnel, appropriate equipment and materials, and adequate time and money to successfully accomplish the implementation project.

Other areas covered within this category include IS managers properly planning and scheduling the implementation, as well as completely defining the new methodology and thereby the scope of the project. The backbone of any implementation is the clear, accurate, and uniformly interpreted definition of scope for the project. Within an SDM implementation, this is the vision of the "total solution" that integrates methodology, tools

and techniques. Finally, the principals must define how the new methodology will affect roles and responsibilities for personnel involved. This task is paramount; as the new SDM will impact not only IS personnel but all functional managers in the organization. Consequently, every effort should be made to involve all stakeholders in the SDM implementation project to facilitate the change process critical to defining the new roles and responsibilities.

Execution and Control Execution and control are the primary processes for carrying out the project plan through coordination and direction of the various organizational resources [5]. Eight questionnaire items address the PM processes of execution and control. Items 8 through 12 pertain to the continued involvement of the project constituents, namely the IS manager, functional managers, and systems personnel. Commitment and involvement within the initiation and planning cycle must be carried through to the execution and control of the project. Participation is believed to increase overall acceptance by enabling development of realistic expectations about the methodology, providing an environment for constructive negotiation on issues, creating a spirit of ownership, decreasing resistance to change, and building commitment. Participation is also believed to increase the quality of the methodology being implemented by improving the understanding of the methodology, providing more complete and accurate requirements, avoiding development of unacceptable processes, and providing necessary expertise about the organization and work processes that will be supported by the methodology.

Other execution and control questionnaire items, 13 through15, address the utilization of existing skills and tracking mechanisms. Tracking the deliverables of the SDM implementation project is a major problem that IS managers must address. IS managers should develop and use measurement methods that adequately track the progress of the project and the development of acceptable, approved deliverables of the SDM implementation project.

Close-out Close-out addresses the formal completion of the project. The close-out process was extended to include practices focusing on implementation after the acceptance of the initial project. Seven survey items address closing and the continued adaptation and infusion of the system development methodology throughout the IT organization. The institutionalization of an integrated package of tasks, activities, tools and techniques offered by the SDM requires the long-term resolve of the organization towards the new methodology after the initial implementation effort. These questions, in general, pertain to the elimination of barriers to the long-term success of the implementation.

SDMs must be adaptable to use new tools and techniques that become available. The implementation of an SDM requires the organization to be poised for an evolving development process and to recognize that change is a continual process. The measures of these factors are found in questions 16 through 18. These changes require modifications and enhancements to the methodology if it is to be compatible with the work processes, tools, and technical environment. Questions 19 and 20 concern the qualification of personnel implementing the new methodology as well as the commitment to have personnel trained in the methodology. For the methodology to be adopted, stakeholders must ensure that the innovation provides relative advantage over the existing norms offered by the previous methodology, compatibility with the organization and its processes, structure, culture and skill sets, and ease of use. A highly complex methodology may result in costs exceeding the benefits. To guarantee these provisions are met, stakeholders are typically trained in a controlled environment. They are able to observe and try the methodology in an atmosphere that is conducive to building internal commitment to the SDM. For these reasons, training programs should be made available to bring everyone's skills in line. Finally, questions 21 and 22 are concerned with ensuring that project teams on projects started during or after the new SDM implementation have sufficient representation and participation of end users.

Data Collection & Results

Upon completion of the initial questionnaire, the instrument was pretested then reevaluated within a pilot study. The pretest was conducted among IS faculty and graduate students at a major university to ensure face validity. A pilot study was then conducted at a major telecommunications carrier that was in the process of implementing an SDM. The instrument was subsequently refined based on comments of the respondents.

Companies were then selected that were qualified and willing to participate in the study. To qualify, the participating company had to be at least two years into implementing the SDM. The first author used IS publications, press releases and contacts at several consulting companies to identify qualified companies to participate in the study. An initial contact person was

identified for each company included in the study. To reduce single response bias, respondents were from four major stakeholder groups of SDM implementation projects: functional managers, IT managers, systems personnel, and external consultants. The company contact selected the individuals participating in the survey because of their personal knowledge and participation in the SDM implementation at their organization. Care was taken to ensure that only knowledgeable people in the appropriate function participated in the study.

A total of 329 surveys were sent to the contact persons in 61 companies. A total of 192 usable questionnaires were returned for a response rate of 58 percent. The largest number of surveys received from any one company was eight. Tables 3, 4 and 5 provide demographics on the companies participating and the methodologies they were implementing. Companies in this study represented a variety of industries, including insurance (13 firms), manufacturing (10), financial, (9), utilities (7), communications (6), retail (6), information services (5), transportation (4), government (2), healthcare (1), and petroleum (1).

Table 3: Demographics of Organizations Responding to the Survey

Industry Type	No of Companies	No of Responses	%
Retail	3	12	6
Transportation	4	6	3
Insurance	11	37	19
Financial	10	31	16
Service	3	9	5
Public Service	10	30	16
Manufacturing	6	14	7
Technical MFG	5	23	12
Health Care	2	7	4
Telecommunications	5	21	11
Oil	1	2	1
Total	105	192	100

Table 4: Demographics of Constituencies

Constituency	Number of Responses
Functional Messages	15
IS Managers	86
Systems Personnel	46
Consultants	45
Total	192

Table 5: Methodologies Being Implemented

	Responses	%
James Martin and Associates	20	11
Navigator	45	23
Texas Instruments Information Engineering Faculty	52	27
Knowledge Ware	21	11
Andersen Consulting (Method 1)	29	15
Miscellaneous (Including Custom)	25	13
Total	192	100%

Most of the companies used methodologies offered by known consulting companies, including: Andersen Consulting Method/1, Ernst & Youngs's Navigator, Texas Instruments Information Engineering, Knowledgeware's Information Engineering, and James Martin & Associates' Information Engineering. An additional group of custom methodologies was also included in the study.

The survey responses provide a comparison between how a respondent felt a project management practice should contribute compared with how the practice currently contributes to SDM implementation within their organization. Table 6 provides the means and standard errors of the survey items. A t-test was used to determine whether there was a significant difference between the two scales. A significant difference was found on every item at the .00 level of significance. We considered the possibility that there were differences in the responses from the different constituencies. An ANOVA conducted on each research item to compare the responses across the primary constituencies failed to show significant differences on any item.

The results present an interesting picture of the SDM implementation process within the research sample of organizations. Respondents consistently indicated that the project management practices should contribute significantly to their SDM implementation project. However, these practices were being utilized to a much lower degree. While the constituents realize the importance of using prescribed norms for effectively managing an SDM implementation project, the project management practices were not being followed to the extent necessary to assure success during SDM implementation projects.

Discussion of Results

Project management is viewed as an enduring, core and organizational requirement for IT organizations [7]. SDM implementations lacking formal planning and control, like all projects, heightens the probability of: (1) poorly defined goals and objectives of what the methodology should accomplish, (2) missed projections on costs, schedules and needed resource requirements, (3) poor communication of needed changes to the organization and its processes, (4) failure to manage the scope of the implementation, (5) unrealistic expectations on the time needed to train staff and integrate the methodology into the organization, (6) and lack of acceptance of the methodology within the organization.

Although project management practices can provide the planning and control necessary to minimize SDM implementation failure, the findings suggest that the practices are often not fully employed. The data analysis showed a consistent gap between what experts and constituents implementing systems development methodologies perceive *should* be practiced and what is *actually* practiced. So why are organizations not practicing what the experts suggest and the stakeholders themselves believe are important project management practices? Since we did not anticipate this gap, specific reasons for it were not researched. We can only speculate but offer several potential reasons.

First, it is likely that IT organizations implementing SDMs are doing so because they are not meeting the demand for critical applications within the company. Such IT organizations would be taxed from mandated daily requirements and critical development projects. It would be difficult if not almost impossible under these circumstances to focus needed attention and resources on process improvement projects.

Another possible problem is that organizations implementing an SDM might not possess the needed skills to successfully design and deploy such a complex process and requisite organizational change. Attewell [1] suggests that lack of know-how and the need for organizational learning constitute difficult barriers in the adoption of complex technologies. One way to overcome these barriers is to use mediating institutions such as consultants and methodologists that specialize in creating and accumulating technical know-how on application delivery processes such as SDMs. Mediating organizations benefit from learning through repetition and the economies of scale afforded by working in domains, such as SDM implementation, that would otherwise rarely occur within an organization [1]. Organizations not using such links to expertise could find it extremely difficult to implement a methodology.

Finally, it is possible that some constituents do not find methodologies attractive and are recalcitrant about the implementation process. Marakas and Hornik [12] posit that gaps such as these found within the study could stem from passive resistance misuse and are the conscious decision of the recalcitrant stakeholder. Passive resistance misuse is "covert behavior resulting from the fear and stress stemming from the intrusion of the technology into the previously stable world of the user. Such behavior takes the form of overt cooperation and acceptance of the proposed system combined with covert resistance and possibly sabotage of the implementation effort [12, pg. 209]." A recent study found users defining standard methodologies as "monolithic, hard to adapt, or modify to a specific situation (system type, project size, business problem) ... voluminous, ... time-consuming [9, pg. 104]." Not wanting the methodology to be implemented, constituents could covertly make it an impossible proposition to implement the SDM [4]. This covert resistance to the SDM implementation offers an interesting alternative explanation as to the gap found in this study

CONCLUSION

As applications become larger and more complex, most organizations are evaluating their application development process. A formal methodology defines a standard process to conduct all the steps necessary to analyze, design, implement and maintain information systems, reducing the risk of delivering deficient software. These benefits, however, cannot be gained until the methodology is successfully introduced and used by an IT organization.

Project management practices are advocated as instrumental in SDM implementation in order to reduce the chance of failure. Although organizational members implementing SDMs believe that core project management processes are important in the successful implementation of methodologies, they felt that the project management practices were not adequately being used within their implementation. More research is needed which explains why these practices are espoused but not practiced.

REFERENCES

[1] Attewell, P. (1992), "Technology Diffusion and Organizational Learning: The Case of Business Computing," *Organization Science*, Vol. 3, No. 1, pp. 1-19.

[2] Alter, A.E. 1996. "F.Y.I.: Systems Development Surprise," *Computerworld*, Vol. 30, No. 7, pp. 68-69.

[3] Davis, W.S., 1994. *Business Systems Analysis and Design*, Wadsworth Inc.: Belmont CA.

[4] Argyris, C. 1977, "Double-Loop Learning in Organizations," *Harvard Business Review*, Vol. 55, No. 1, pp. 115-125.

[5] PMI Standards Committee, 1996. *A Guide to the Project Management Body of Knowledge*, Project Management Institute: Upper Darby, PA.

[6] Dawson, S. P., 1994. "Continuous Improvement in Action: Applying Quality Principles to Software," *Information Systems Management*, Vol. 11, No. 1, pp. 74-76.

[7] Feeny, D. & Willcocks, L., 1998. "Core IS Capabilities for Exploiting Information Technology," *Sloan Management* Review, Vol. 39, No. 3, pp. 9 –21.

[8] Gill, P., 1999. "Project Management Gets Little Attention," *InformationWeek*, No. 718, p. 14.

[9] Hidding, G. J., 1997, "Reinventing Methodology: Who Reads It and Why?," *Communications of the ACM*, Vol. 40, No. 11, pp. 102-109.

[10] King, J., 1997. "Poor Planning Kills Projects, Pushes Up Costs," *Computerworld*, Vol. 31, No. 38, p.6.

[11] Martinez, E.V. 1994. "Avoiding Large-Scale Information Systems Project Failure: The Importance of Fundamentals," *Project Management Journal*, Vol. 25, No. 2, pp. 75-80.

[12] Marakas G.M, and Hornik S. 1996. "Passive Resistance Misuse: Overt Support and Covert Recalcitrance in IS Implementation, *European Journal of Information Systems*, Vol. 5, No. 3, pp. 208-219.

[13] Newton, M. and Saberwal, R., 1996. "Determinants of Commitment to Information Systems Development: A Longitudinal Investigation," *MIS Quarterly*, Vol. 20, No. 1, pp. 23-54.

[14] Paulk, M.C. 1995. *The Capability Maturity Model: Guidelines for Improving the Software Process*, Addison Wesley: Reading, MA.

[15] Paulk, M. C., Curtis, B., Chrissis, M. B., & Weber, C. V. (1993). *Capability maturity model for software, version 1.1. CMU/SEI-93-TR-24*, February. Software Engineering Institute.

[16] Whitten, J.L., and Bentley, L.D., 1997. *Systems Analysis and Design Methods*, Irwin McGraw-Hill: Boston, MA

[17] Wynekoop, J. and Russo, N.L., 1993. "System Development Methodologies: Unanswered Questions and the Research in Practice Gap," *Proceedings of the 14th Annual International Conference on Information Systems*, Ed. Degross, Bostrom, and Robey.

[18] Wu M.S., and Wu, S.S, 1994. *Systems Analysis and Design*, West Publishing Co.: Los Angeles:CA

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