Factors that Impact Implementing a System Development Methodology

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Abstract—This paper presents the findings of empirical research from 61 companies, mostly from the United States, to identify the factors that may impact implementation of a system development methodology (SDM). The study uses a survey instrument to identify the SDM implementation factors. The survey focused on the perspective of the primary constituents: functional managers, information systems managers, system personnel, and external consultants. The study uses an exploratory factor analysis that identifies five factors important to implementing an SDM: organizational SDM transition, functional management involvement/support, SDM transition, the use of models, and external support. The research findings have important implications for further research and the practice of system development. For researchers, it points to important measures in the implementation and use of SDMs that may be further verified and extended in subsequent research. For practitioners, it provides a general guide to the important aspects to consider in the implementation and use of an SDM.

Index Terms—Systems development methodology, analysis and design, project management, life cycle, managers, implementation.

1 Introduction

An important issue facing information systems (IS) managers is improving the effectiveness of software development [8]. Many organizations are attempting to implement system development methodologies (SDMs) to aid in this effort. SDMs can improve the system development process once an understanding of the fundamental principles are attained [1]. In modern IS environments, an SDM comprises an overall strategy for computer-based information system development that includes a flexible framework of the sequence of development tasks along with the techniques used to accomplish each task. Unfortunately, this definition is not the only definition for SDM. The IS literature contains as many definitions of SDM as there are SDMs, of which hundreds exist. As Bachman [2] states, "A methodology is a way to skin a cat." Simply defined, an SDM is a way to develop a system, and for the purposes of this paper an information system.

SDMs provide the potential for helping to alleviate the software development and maintenance problems that plague many IS departments [25]. Initial SDMs were developed to attempt answer complexity problems associated with system development [13], [16], [23]. One study has shown the need to develop rigorous methods to develop system requirements to increase reliability and decrease costs of systems for organizations [7]. Other studies have shown that errors late in the development process are more costly than errors corrected early in the process [4], [5], [7], [17], [18], [28]. SDMs offer an alternative to risky, informal, and intuitive system development methods, which are frequently used in practice [40]. The use of formal SDMs is important for several reasons:

1) they are teachable
2) they provide consistency because everyone uses the same techniques
3) they require explicit deliverables that may be checked for quality
4) they provide an engineering-like development discipline [3], [15], [22], [29], [39]

Some prominent SDMs include Ernst & Young's Navigator, Andersen Consulting's Method/1, James Martin and Associates' Information Engineering, McDonnell-Douglas Consulting's Stradis, and CGI's Marise.

Only recently has attention been directed to the rigorous adoption of SDMs. This attention is partly due to the proliferation of support tools such as Computer Aided Software Engineering (CASE) tools. Orlikowski [32, p. 309] used two case studies to "explain and evaluate different experiences and consequences following the introduction of CASE tools in organizations." CASE tools simply automate portions of a system development methodology. A more important research focus should be to research what CASE tools actually automate, e.g. an SDM. SDMs should be the primary implementation focus rather than the tools that support automating the methods of SDMs. Several research studies search for the principles of CASE that support system development and compare SDMs [6], [10], [21], [24], [26], [27], [30], [35]. Other studies have compared various development methods [20], [36], [38], [41], [42]. Appendix A lists

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practitioner articles used as background information on SDM and research related to SDM.

Many articles describe individual methodologies (see Appendix A). Most articles concerning SDM implementation are anecdotal and/or oriented toward descriptive suggestions for the practitioner community. These articles are intended to be informative rather than methodologically rigorous and, in the strictest sense, do not constitute generalizable research concerning implementing an SDM. A number of articles report actual cases describing the implementation of a particular SDM. The implementation of a new SDM as a new technology in the organization will have a great impact on the organization [33], [37]. However, an assessment of the literature does not reveal a generalizable study that identifies factors that impact the implementation of SDMs. This research provides a list of five generalizable factors that impact the implementation of SDMs in organizations.

Our study examines SDM implementation from the perspectives of the multiple constituents that are involved in the change process to the SDM and application of the SDM upon its implementation. The basis for our study encompasses answering our primary research question that follows.

1.1 The Research Question

What are the factors that profile the organizational changes that impact the implementation of a systems development methodology?

While practitioners and researchers state the importance of SDMs, very little generalizable research concerning SDM implementation exists. Several distinct issues make implementing an SDM very important from both researcher and practitioner points of view. First, the use of an SDM allows organizations to standardize the development process and address system application backlogs. Second, research studies and practitioner articles have stated that in order for an organization to successfully use available automated tools to support system development, they must first implement an SDM. Third, if properly used, SDMs should help organizations integrate business modeling with information system modeling and development. Integration helps to more closely link IS with business processes. Finally, the significant commitment of resources necessary to implement an SDM makes smooth implementation important to every organization.

1.2 Importance of the Research to the Business Community

IS managers, functional managers, systems personnel, and external consultants should find the research results interesting and informative. The study provides a list of the factors affecting SDM implementation from the perspective of the primary constituencies. Practitioners should focus efforts on the key factors identified in this study to ensure better SDM implementation in their organization. Researchers should focus further research on verifying factors and help determine cause and effect.

This paper provides five primary contributions:

1) identification of five key factors for IS managers to consider when attempting to implement an SDM
2) the rich content of a preliminary study with experts and a final study of constituents involved in implementing an SDM in 61 companies provides a grounded comprehension of the change aspects in implementing an SDM
3) the creation of a research instrument rich in content for studying the implementation of methods, practices and methodologies
4) an understanding of the central role played by the different constituencies involved in the implementation and use of an SDM
5) providing an understanding of elements that influence implementing an SDM, a fundamental component of system development, an SDM.

2 Research Methodology

This investigation is a theory-building exploratory study to identify factors that impact SDM implementation as viewed by primary constituencies. The study was conducted in two parts: first, structured interviews were conducted with a panel of experts; second, using information from the interviews, a survey instrument was designed and mailed to a broad sample of organizations.

2.1 The Preliminary Study

The preliminary study consisted of structured interviews with SDM experts. Converse and Presser [12] state that it is necessary to interview experts in a field for questionnaire development. For this reason, a panel of experts was used to gain a better understanding of the research topic. Furthermore, the use of experts helped eliminate any bias held by the researchers.

The researchers selected 12 experts using citation lists and members of a prominent business association. All the experts are very knowledgeable regarding the topic of SDM. A content analysis was performed on each interview transcript. The content analysis permitted the researchers to "draw out the significance of various levels of analysis and thereby reveal multiple sources of loops of causation and connectivity so crucial to identifying and explaining patterns of the process of change." The results of the content analysis were compiled and collectively evaluated with items of importance to SDM implementation identified. These items were included in the research instrument. The constituencies involved in implementing an SDM were also identified during this analysis. The four primary constituencies identified are: functional managers, IS managers, systems personnel, and external consultants involved in the implementation process.

The term constituency, rather than the term participants, is used to emphasize that individuals and groups not directly associated with the focal organization may form evaluations of the organization's activities and/or may influence the activities of the organization to some extent [11]. The multiple constituency approach is a method of assessing organizational effectiveness from the perspectives of multiple strategic constituents [9]. Different stakeholders

have different perceptions of effectiveness. The multiple constituency approach limits the bias inherent in measuring effectiveness from the perspective of a single constituency. The multiple constituency approach provides a "structuration perspective" [14], [34] that emphasizes "the centrality of players' deliberate, knowledgeable, and reflective action in shaping and appropriating an SDM," [32, p. 310].

Functional managers, IS managers, systems personnel, and external consultants view implementing SDMs from different perspectives. At the start of the research project, the researchers proposed that such different perspectives may lead to different perceptions of the factors critical to SDM implementation. Because all four of these primary constituencies were involved in the SDM implementation process, the use of a multiple constituency approach for identifying important factors is appropriate [see for example, Hamilton and Chervany, 1981 and Watson, Boyd-Wilson, and Magal, 1987].

2.2 Survey Research Strategy

The survey research instrument used for this investigation was a mail questionnaire. The reason for using the survey strategy is the need for a large sample representing the primary constituencies. The questionnaire included information needed to evaluate factors that impact implementing an SDM. Possible items related to these factors were identified in the expert panel investigation. The expert interviews helped to ensure content validity for the items in the research questionnaire. The order of the items on the questionnaire was random.

A rating 6-point Likert scale was used to measure the intensity of the response (See the questionnaire in the Appendix). The 6-point scale was used in preference to the more familiar 5-point Likert scaled in order to force respondents to one side or the other regarding agreement or disagreement with the items: no neutral responses were permitted. Following each item was an agreement scale ranging from 1 (Not At All) to 6 (Very Great Extent). Respondents were asked to indicate on the scale the degree to which they experienced the actual contribution of the item to SDM implementation in their organization.

Once the initial questionnaire was created, pretest and pilot studies were performed. The pretest of the research instrument was conducted among IS faculty and graduate students at a major university to ensure readable and understandable wording of the research instrument. A pilot study was conducted with a major telecommunications carrier that was in the process of implementing an SDM. All four constituencies from the company's SDM implementation responded to the questionnaire. The instrument was subsequently refined based on comments of the respondents.

2.3 Data Collection

The first phase of the data collection effort was the selection of companies qualified for the study and willing to participate. To qualify for the study, the participating company had to be at least two years into their SDM implementation process. The researchers used the literature and contacts at several internationally known consulting companies to identify potential companies to participate in the study.

An initial contact person was identified for each company included in the investigation. This contact person secured approval to administer the questionnaire in the company. Questionnaires were sent directly to the contact person in a single mailing. The contact person selected knowledgeable individuals that were personally involved in the organization's SDM implementation. The company contact person selected the individual respondents because of their personal knowledge of the SDM implementation at their organization. Every effort was made to ensure that only knowledgeable individuals participated in the survey. The contact person distributed the instrument to the respondents in the organization. Each respondent returned their sealed questionnaire to the contact person, who mailed the collection of responses back to the researchers in a large sealed envelope.

Most of the companies selected used one, or more, of the following SDMs: (Table 1) Andersen Consulting's Method/1, Ernst & Young's Navigator, Texas Instrument's Information Engineering, Knowledgeware's Information Engineering, and James Martin & Associates' Information Engineering. An additional grouping of individual and in-house, custom methodologies were also included in the study.

TABLE 1
DEMOGRAPHICS REGARDING THE SDMS IMPLEMENTED BY COMPANIES IN THE STUDY

SDM	No. of Responses
Ernst & Young Navigator	45
Anderson Consulting METHOD/1	29
TI Information Engineering	52
KW Information Engineering	20
JMA Information Engineering	20
Custom and Other SDMs	26
Total	192

2.3.1 Sample Demographics

Tables 2 and 3 provide demographics of the companies and respondents of the study. A total of 61 companies agreed to participate in the study. These companies represent many types of service and manufacturing industries. The sample of responding companies included 56 from the United States and five from Canada.

Companies in this study represented a variety of industries, including insurance (13 firms), manufacturing (10), financial (9), utility (7), communications (6), retail (6), information services (5), transportation (4), government (2), healthcare (1), and petroleum (1). The companies were geographically dispersed across the United States and Canada. The northeast region (20 firms) had the highest number of companies, followed by the midwest (10), west (10), southeast (9), southwest (5), and northwest (2).

A total of 329 surveys were sent to the contact persons in the 61 companies. The companies returned 192 completed surveys for a response rate of 58.35 percent. The largest number of surveys received from any one company was 8.

TABLE 2
DEMOGRAPHICS REGARDING THE RESEARCH CONSTITUENCIES

Constituency	No. of Responses
Functional Managers	15
IS Managers	86
Systems Personnel	46
Consultants	45
Total	192

TABLE 3
SAMPLE RESPONDENT'S DEMOGRAPHICS

No. of years of IS or Business Experience	No. of Respondents
0-3	1
3-5	5
5-10	44
10-20	95
20 or more	46
No response	1
Total	192

Age	No. of Respondents
20-29	13
30-39	74
40-49	83
50-59	17
Over 60	1
No response	4
Total	192

Gender	No. of Respondents
Male	133
Female	58
No response	1
Total	192

2.4 Data Analysis

After completing data collection, a series of analyses were performed to address the research question. These analyses include an exploratory factor analysis and ANOVA procedures.

2.4.1 Factor Analysis

An exploratory factor analysis was conducted to find any dimensions underlying the items relating to implementing an SDM. This method was chosen due to the limited amount of knowledge available on SDM implementation and the exploratory nature of research.

One of the necessary requirements of the factor analysis procedure is a large sample. A general rule of thumb is that the number of subjects should be at least two times greater than the number of variables [19]. In this investigation, the number of items used in the questionnaire was 88, with the 192 returned responses meeting the criterion established for the study.

The researchers used two criteria to evaluate the factor items: significance of item loadings and simplicity of factor structure. Using the first criterion, only items with factor loadings of at least 0.35 were retained. The second criterion calls for eliminating items that exhibit factor loadings of 0.35 on two or more factors, or items that exhibit no factor loadings greater than 0.35.

Cronbach's coefficient alphas were used to test internal reliability of the factors. Cronbach alpha's of at least 0.60 were used to estimate reliability for each factor [31].

2.4.2 Analysis of Variance

An ANOVA procedure was conducted on each research item after the final factor analysis. This procedure was used to compare the responses across the primary constituencies. Each research item was tested at the 0.05 significance level using the F-statistic to determine if significant differences existed across the constituencies.

3 RESEARCH RESULTS

The ANOVA procedure comparing responses from the different constituencies failed to show significant differences on any item. These findings confirmed the researchers' assertion of having a homogeneous sample regarding the implementation of an SDM, but did not confirm the a priori assertion that the different perspective of the constituencies would lead them to value different items as important to the implementation.

The exploratory factor analysis procedure using a varimax factor rotation was performed for the 88 items. No factors were specified on this initial factor analysis, resulting in a 21-factor solution. An analysis of the scree plots showed a drop (1.30 to 0.625) in the eigenvalue levels and a drop below 2 percent of the variance explained after factor 5. These values from the scree plot indicated a 5 factor solution.

A subsequent factor analysis was performed forcing a 5-factor solution and factor loadings of at least 0.35. This procedure resulted in five factors with eigenvalues of at least 1.68 which exceed the minimum standard of 1.0 for acceptable factors. Ten of the 88 items failed to meet the 0.35 factor loading requirement and were subsequently eliminated from the analysis. Thirteen additional items crossloaded and were also dropped from the analysis. In total, five factors explained 43.7 percent of the systematic covariance among the remaining 65 items.

3.1 Identifying Factors

Five factors were identified in the exploratory factor analysis procedure conducted for the study. The items that loaded on each factor can be identified and explained by analyzing Table 4. The discussion pertaining to the factor analysis results tables describes the factors, their assigned latent variable names, and the importance of each factor.

The first factor identified (Table 4) included 28 items related to following through with SDM implementation. These items were related to SDM training, IS manager involvement with the process, and organizational change. The latent variable name assigned to this factor is *organizational SDM transition*. This factor actually encompasses the change over from the old ways to the new SDM. This factor

TABLE 4
ORGANIZATIONAL SDM TRANSITION
(CRONBACH'S ALPHA = 0.95, FACTOR MEAN = 3.73)

	Factor Item	Loading
8	IS managers committing IS resources to the methodology implementation	.64
10	Commitment to the new methodology throughout the organization	.64
15	All personnel understanding the benefits of the new methodology	.63
62	Convincing the development staff that changing to the new methodology is in their best interests	.62
5	Having the proper people carrying the message that methodology implementation embodies a ultural change	.62
72	Knowledge of how the new methodology will affect roles and responsibilities for personnel involved	.59
21	Appropriate personnel involved in each methodology implementation phase	.59
19	Managing the transition to the new methodology	.59
75	Structuring methodology training courses to meet organizational needs	.58
32	Personnel qualified to execute the transition to the new methodology	.57
58	The commitment of IS managers to having personnel trained on the new methodology	.56
9	Training on the methodology's phases, tasks, and deliverables	.56
71	Training on the methodology's approach	.53
7	Systems personnel involvement in implementing the new methodology	.52
6	Understanding what parts of methodology are flexible and what parts are rigid	.51
53	Personnel involved in the implementation process having a complete understanding of the new methodology	.50
31	Training on the tools supporting the methodology	.48
27	Having a methodology coordinator	.48
14	Training on all aspects of the life cycle	.47
79	Training on the discipline of completing tasks as prescribed by the methodology to ensure quality	.46
66	In-house trainers that have actual project experience using the new methodology	.44
46	Creating methodology training materials	.43
84	Training on the benefits of reusability	.42
61	Developing your own in-house training program	.40
67	Completely defining the new methodology for those involved in the implementation process	.38
69	Developing different training paths for different types of jobs	.38
18	Separate training on different techniques	.37
4	IS managers realizing that many of their skills and those of their employees may be obsolete	.37

is interesting because items pertaining to preparing and enforcing the changeover to the new SDM are all part of the factor. Preparation is essential for any major change in an organization. A major part of the preparation for employing a new SDM is adequate training and the application of the proper resources in terms of knowledgeable personnel and equipment. Each of these areas can be identified by items loading on this factor. The enforcement of the use of the new SDM is also included in this factor through the involvement of IS managers. IS managers are the empowered individuals involved with the SDM implementation process. Successful implementations of SDMs need direct involvement of IS managers. This factor is important because SDM implementations are difficult to complete without proper preparation for change and IS manager support.

Factor 2 (Table 5) consists of the nine items associated with functional managers and their relationship to the SDM implementation process. All of the items relating to functional managers loaded on this factor. The latent variable name given to this factor is *functional manager involvement/support*. Functional managers are the chief proponents of change in virtually all organizations. The functional management component is a part of the preparation of the organization for change and enforcement of the change. The role of functional managers is different than IS managers in that they most likely will not be directly involved in the new SDM. However, functional managers provide resources, commitment, and discipline for implementing the new SDM throughout the organization. Functional management provides resources in terms of funding, technology, personnel and external training support. Functional management can champion changes in the organization to sell the new ideas to personnel. Finally, functional management can enforce the changes to the new SDM. This factor is vital for any type of major change in an organization.

Factor 3 (Table 6) is another transition factor. The 10 items included in Factor 3 are aspects of SDM implementation involved directly with changing to the new methodology. The latent variable name for this factor is *SDM transition*. Unlike Factors 1 and 2, which address forward transition of SDM facets, Factor 3 addresses understanding specific SDM transition phases. Understanding the new life cycle and activities of the SDM were a part of this factor. Each SDM presents a new system development life cycle with distinctly identifiable phases. Personnel must know these phases and the tools and techniques that are used in each of these phases for implementation to be successful. Additionally, the deliverables of each phase of the life cycle are distinct and must be understood as inputs to the next phase. This factor is vital to the future use of an SDM because company personnel must have a complete understanding of activities and transitional phases in order to use the SDM.

TABLE 5
FUNCTIONAL MANAGEMENT INVOLVEMENT/SUPPORT
(CRONBACH'S ALPHA = 0.92, FACTOR MEAN = 3.16)

	Factor Item	Loading
30	Functional management forcing adherence to the methodology	.74
34	Functional management tracking methodology implementation deliverables	.71
42	Functional management committing resources to methodology implementation	.68
76	Functional management formally announcing commitment to the new methodology	.67
38	The involvement of functional managers throughout the methodology implementation	.66
55	Functional management providing measurement methods to track the methodology implementation process	.61
26	The commitment of functional managers to having personnel trained on the new methodology	.60
70	Having middle and lower functional management involved in the methodology implementation process	.60
51	Functional managers creating a plan for the methodology implementation	.53

TABLE 6
SDM TRANSITION
(CRONBACH'S ALPHA = 0.85, FACTOR MEAN = 3.67)

	Factor Item	Loading
41	Understanding when some life cycle phases may be shortened or eliminated	.55
45	IS managers tracking methodology implementation deliverables	.51
50	Realizing tools, such as CASE, simply automate the techniques of the methodology	.51
37	Understanding the deliverables of each life cycle phase	.47
28	Recognizing that change is a constant process	.46
73	Realizing the importance of system development activities as part of the methodology	.46
24	Capitalizing on existing skills while implementing a new methodology	.45
29	Balancing the IS strategic views to the organization's overall strategic goals and objectives	.43
87	Realizing all projects do not lend themselves to prototyping	.40
54	Understanding that automated support is critical to any methodology	.39

Factor 4 (Table 7) contains nine items related to modeling. The latent variable name given to this factor is the *use of models*. Again, most SDMs use modeling methods. Models serve the purpose of explaining the business and giving clear definitions of how the business works to IS personnel and end users. Knowing how and when to use specific models is a vital part of IS personnel jobs. IS personnel should understand the relationship between the various modeling techniques, where the techniques fit into the life cycle and what each modeling technique brings to the system development process. Additionally, the deliverables of each modeling technique should be defined and spelled out in the system development process. The reason this factor is important to the SDM implementation process is that models are a functional component of SDMs that must be understood before an SDM can be implemented or used.

Factor 5 (Table 8) includes nine items related to the use of external training and consultants. The latent variable name assigned to this factor is simply *external support*. External consultants play a major role in implementing most SDMs, especially in initial implementation phases. Organizations frequently need outside expertise because, in many cases, no one in the organization has the expertise required to effectively implement an SDM. Furthermore, external training is frequently needed because internal trainers do not have the specialized skills and expertise to develop training courses and materials. Factors 1, 3, and 4 are areas where expertise from external consultants can impact an organization's implementation of an SDM. External consultants bring knowledge from other implementations of SDMs into the organization. This knowledge can include training procedures, expertise on the specific methodology and its phases and techniques, and just simply proof to everyone that other implementations of SDMs have been successful in other organizations. The importance of this factor cannot be overstated if the organization does not have adequate resources or expertise internal to the organization to implement and use the SDM.

4 IMPLICATIONS OF THE STUDY

This study is valuable to IS developers and researchers because it identifies key areas companies need to address while implementing an SDM and provides research results on a baseline IS component, an SDM. The exploratory factor analysis provided very interesting results regarding what factors actually impact SDM implementation. The exploratory factor analysis revealed that many factor items related to transition, SDM training, SDM enforcement, and IS manager support all loaded on a single factor. This result is interesting because it reveals that most companies are not currently addressing the important aspects of following through with the SDM implementation. Companies are currently experiencing difficulties in dealing with the actual transition from the old way to the new SDM. The struggle in SDM implementation seems to lie in the actual transition from old to new, not the preparation for the change.

TABLE 7
USE OF MODELS
(CRONBACH'S ALPHA = 0.85, FACTOR MEAN = 3.53)

	Factor Item	Loading
16	Creating models of the business [either enterprise or functional models]	.73
20	Creating or using information models	.71
25	Linking IS development to the business model.	.57
68	Realizing that models provide the means for business process reengineering	.48
47	Understanding the connection between the different levels of abstraction from the business model down through the system model and actual system	.47
2	Understanding the importance of keeping the business model up-to-date	.45
88	Systems personnel communicating with end users to determine the needs of the business processes	.38
12	For projects started during or after methodology implementation, a development team that includes end users [managers/staff]	.37
77	Selecting the correct automated tools to keep systems requirements from conflicting	.37

TABLE 8
EXTERNAL SUPPORT
(CRONBACH'S ALPHA = 0.84, FACTOR MEAN = 3.10)

	Factor Item	Loading
65	External consultants that provide expertise and experience in using the methodology	.70
39	The assistance of external consultants in developing an internal training plan	.68
56	Externally supplied training at the beginning of the methodology implementation process	.66
74	External consultants returning at a later date to insure changes to the development process are properly completed	.64
48	External consultants that provide evidence of the value of the new methodology	.57
35	External consultants training in-house trainers to perform to perform future training	.50
52	Software and hardware vendors providing training for their products	.40
49	Using public training seminars to share ideas with personnel from other organizations	.38
43	Using public training seminars to expose personnel to the methodology	.36

Another interesting finding is the lack of significant differences in the perceptions of the factor items between the primary constituencies. It is surprising that each constituent group did not have their own particular perceptions of the items but responded in a homogeneous way. This homogeneous response may arise from the fact that most organizations tend to use their best personnel when making major changes, such as SDM implementation. Companies usually put their most experienced and skilled personnel on major projects, such as SDM implementation. A review of the business and IS experience, and education level of the respondents in Table 3 reveals that most companies in the study used their most experienced and more educated personnel during their implementation process.

Although the results of this study should be further validated through replication and further studies conducted on the subject, the findings of this research identifies items of importance related to the five factors detected in the study that should help practitioners attempting to implement an SDM. For researchers, the study provides a framework for further study regarding SDM implementation.

5 SUMMARY AND CONCLUSIONS

The study yielded five factors that should be considered **currently** important to companies implementing SDMs. The five factors identified are:

1) Organizational SDM Transition
2) Functional Management Involvement / Support
3) SDM Transition
4) Use of Models
5) External Support

The factors dealing with transition from the old to the new comprise the discipline of actually carrying the SDM processes forward in the organization. The forward transition part of the implementation process appears to be the most troublesome area.

Organizations allocate significant resources to implement SDMs. It seems strange that, although SDMs are not new, companies still encounter major difficulty when trying to implement them. This study identifies factors that currently are affecting organizations prior to, and during SDM implementation. It also pinpoints current areas of concern and valuable information for any organization trying to implement an SDM. The authors believe that the results here help organizational managers in identifying the main areas where they should focus their efforts in implementing an SDM. By considering the specific items that comprise the five factors, managers may be able to direct organizational personnel in better implementing an SDM. By better implementing an SDM, these same organizational managers can better ensure that system development projects be better completed as suggested by those authors of various types of books on system development methodologies. The results of this research also provides a foundation for further research on the SDM implementation process.

5.1 Directions for Future Research

This study provides a basis for many different avenues for future research. A first study should replicate this study with different but similar samples using additional SDMs (including some object-oriented SDMs). These research projects should help validate the constructs identified in the exploratory factor analysis of this study. A broader international extension of this study should also be conducted for further validation, since many SDMs are being used globally.

Another valuable future study consists of longitudinal case studies that look at an SDM implementation from start to finish for different companies using the same and different SDMs as in this research. This study could help identify latent problems and obstacles from a longitudinal perspective that companies must address while implementing an SDM. The subject companies for these case studies should be conducted beginning at the start of the SDM implementation processes spanning 3-5 years and encompassing the full implementation process.

A study that explores the system development process for organizations not having a formal SDM could help compare SDM and non-SDM environments and should be of interest to many researchers and practitioners. Such a study could provide insight regarding the actual impact of SDMs on the system development process.

The expenditure of time and effort in implementing an SDM makes it one of the most serious areas of concern in modern IS. The study's results provide a foundation on which to base the implementation of an SDM. A close scrutiny of an SDM implementation can be performed by tracking the attributes of the items of importance to the five factors found in this research.

APPENDIX A
PRACTITIONER ARTICLES RELATED TO SDMS

A.1 Articles on SDMs in General or Specific SDMs

Bendure, C.O. A Case Study on CASE: Its Evolution and Use at HHMI. *Journal of Information Systems Management*, *8*, 4 (1991), 50-56.

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Ramsower, R. and King, J.R. A CASE of the 'Shoemaker's Children'. *Baylor Business Review*, *7*, 1 (1989), 20-24.

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Vandercook, R.G. The Case for CASE. *Systems/3X AS World*, *17*, 6 (1989), 88-96.

Veryard, R. Future of Information Systems Design Methodologies. *Information and Software Technology*, *29*, 1 (1987), 33-37.

Wallace, S. Methodology: CASE's Critical Cornerstone. *Business Software Review*, *7*, 5 (1988), 17-20.

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A.2 SDM Implementation Articles

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