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Special Theme of Research in Information Systems Analysis and Design-IV Evaluation Criteria for Information Systems Development Methodologies

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SPECIAL THEME OF RESEARCH IN INFORMATION SYSTEMS ANALYSIS AND DESIGN - IV

EVALUATION CRITERIA FOR INFORMATION SYSTEMS DEVELOPMENT METHODOLOGIES

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ABSTRACT

The evaluation of information systems development methodologies is becoming increasingly important. Some researchers propose their own criteria for conceptual evaluations. But such criteria are often constrained by the limitation of the researcher's view toward and experience with development methodologies. Furthermore, existing evaluation criteria are either not practical for direct measurement or not tested for validity and reliability. The lack of a generally acceptable, practically valid, and reliable set of criteria for evaluation hinders the development of knowledge in this area. Our study is a step toward developing a systematic process to evaluate information systems development methodologies. We captured the opinions of a group of twenty-eight researchers and practitioners who are experienced in information systems development methodologies. Through a systematic content analysis, the authors classified these criteria into three categories: (1) methodology design, (2) methodology use, and (3) methodology deliverables. The three categories of criteria are not totally separate in that they represent the means and goals of information systems development methodologies. Appropriate criteria should be applied depending on the stages when evaluation is performed.

KEYWORDS: Information systems, methodologies, evaluation, criteria

I. INTRODUCTION

Developing information systems is always a challenging task. The early information systems were largely developed and implemented without explicit or formalized development methodologies. The systems development was primarily dependent on programmers' experience and expertise. Such individualistic approaches often resulted in poor control and management of the development projects, ill-defined user needs, and low user-satisfaction [Avison and Fitzgerald, 2003b]. Confronting these issues, many software development organizations devised their own or

adapted existing development methodologies, hoping to improve the management and control of projects, and to standardize the development process and product.

Many different information systems development (ISD) methodologies exist. Bubenko [1986] suggests the number is in the hundreds while Jayaratna [1994] estimates the existence of over 1000 ISD methodologies. Avison and Fitzgerald [1995] point out that the numbers might be overestimates because many ISD methodologies are similar and differentiated only for marketing purposes. Nevertheless, Avison and Fitzgerald [1995] acknowledge the proliferation of ISD methodologies and refer to it as "the methodology jungle."

Although it is evident that considerable attention is devoted to developing ISD methodologies, the evaluation of existing ISD methodologies is not keeping pace with the rapid growth of ISD methodologies. The important ramifications of a dearth of research on ISD methodologies evaluation are:

1. By failing to evaluate currently used ISD methodologies, organizations may not clearly comprehend the usefulness and effectiveness of ISD methodologies.

2. The lack of ISD methodologies evaluation inhibits practitioners and researchers trying to understand the strengths and weaknesses of various methodologies. This understanding is critical knowledge for improving existing methodologies or designing new ones.

Evaluating ISD methodologies is an imperative task for both practitioners and researchers, and warrants more research. If we view ISD methodologies as objects of study, we must develop a systematic way for the investigation, including

- concepts for the description and comparison of ISD methodologies, and
- criteria for their evaluation and assessment [Floyd, 1986].

Developing a set of generally acceptable criteria is one of the first steps to developing a systematic process to evaluate ISD methodologies.

Some researchers contributed to this issue by summarizing their own checklists of requirements of an ISD methodology. The checklists were then used as the *de facto* criteria for evaluating different ISD methodologies. The main problem with such checklist approaches lies in subjectivity. It is often a subjective task for researchers to develop their own criteria [Avison and Fitzgerald, 1995, Siau and Rossi, 1998]. In addition, the checklists are potentially constrained because of the inevitable limitations of individual researchers' view toward and experience with ISD methodologies. Some evaluation criteria are not practical for direct measurement, and few have been tested to determine their validity and reliability.

Our study is a step toward filling the gap in the ISD methodologies evaluation literature. We surveyed a group of experienced researchers and practitioners. They were asked to brainstorm a list of criteria deemed relevant and important for evaluating ISD methodologies. This opinion polling method is appropriate in this study because we intend to generate a list of evaluation criteria that is as comprehensive as possible. Then, the authors conducted a systematic content analysis to categorize the criteria generated. The resulting list of criteria is suitable for designing scales and follow-up testing.

This paper is organized as follows: Section II reviews the literature on ISD methodologies and prior evaluation studies. Section III describes our research method. Section IV reports the findings of our study, discusses their implications for ISD evaluation research and practice, and compares the findings with existing frameworks of ISD methodology evaluation. Section V presents our conclusions.

II. BACKGROUND AND MOTIVATION

To alleviate the problems caused by individualistic approaches in early information systems development efforts, many organizations turned to ISD methodologies. The methodologies offer an engineering-like development discipline, provide explicit deliverables, and safeguard the consistency as information systems are being built.

In this section, we first clarify the terminologies related to ISD. Then, we review existing IS literature on evaluating ISD methodologies. Finally, we summarize the motivation of our study.

TERMINOLOGIES RELATED TO ISD

The four-tiered framework proposed by Iivari et al. [2000] is helpful in clarifying the seemingly confusing terms, concepts, and notions that are closely related to ISD. Iivari et al. [2000] explore the notions of paradigms, approaches, methodologies, and techniques in the context of ISD. The four notions are described as below [Iivari et al., 2000], and its hierarchy structure is shown in Figure 1.

- Paradigms. ISD paradigms refer to a set of basic beliefs held by the creator of specific ISD approaches or methodologies. The three fundamental concepts are beliefs concerning the nature of reality (ontology), how knowledge is acquired (epistemology), and the values that should guide research investigation (ethics). ISD paradigms include functionalism, social relativism, neohumanism, and radical structuralism [Iivari et al., 1998].

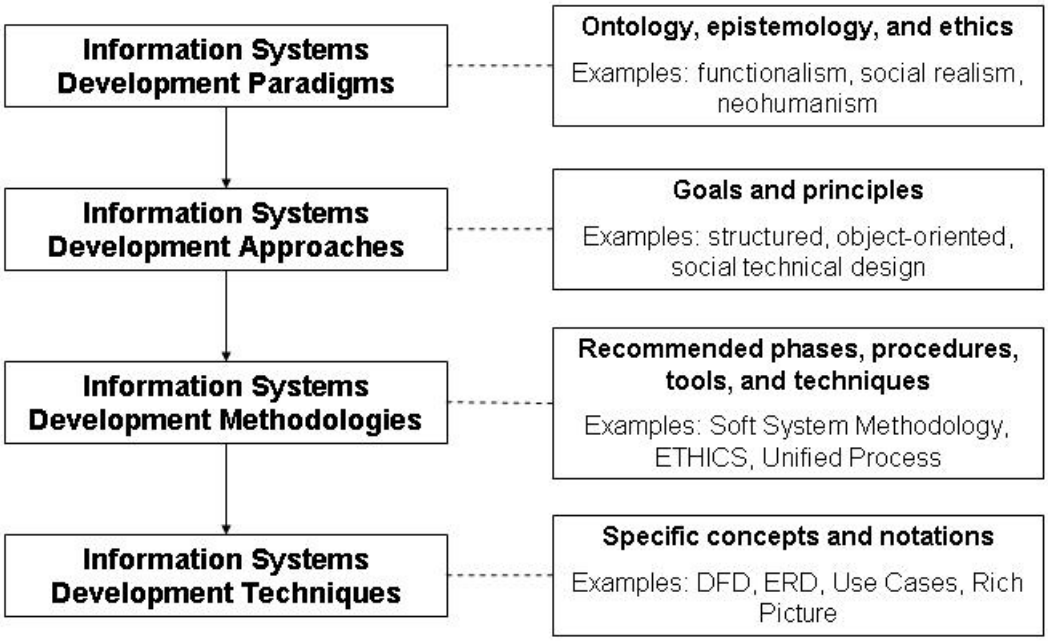

Figure 1. The Hierarchy of ISD terms

- Approaches. An ISD approach is a class of specific ISD methodologies that share a number of common features, such as goals, guiding principles, fundamental concepts, and principles for the ISD process. Examples of ISD approaches include object-oriented (OO) and structured analysis / structured design (SA/SD).
- Methodology. An ISD methodology is a codified set of goal-oriented procedures which are intended to guide the work and cooperation of the various stakeholders involved in

the building of an information systems application. Typically, these procedures are supported by a set of preferred techniques and tools, and guiding principles. Soft Systems Methodology and Unified Process are examples of ISD methodologies.

- Technique. An ISD technique consists of a well-defined sequence of elementary operations for conducting a portion of a phase in development. Common ISD techniques include modeling techniques, such as Data Flow Diagrams (DFD) and Entity Relationship Diagram (ERD).

For the purpose of this paper, we offer a definition of an ISD methodology, largely based on Avison and Fitzgerald [1995, 2003b] and Lyytinen [1987]:

> *An ISD methodology* is *a systematic approach to conducting at least one complete phase of information systems development, consisting of a recommended collection of phases, procedures, techniques, tools, and documentation aids*.

A BRIEF HISTORY OF ISD METHODOLOGIES

Avison and Fitzgerald [2003b] offer an excellent review of the history of ISD methodologies. They split the evolution of ISD methodologies so far into four eras (Table 1).

Table 1. The Evolution of ISD Methodologies

Era	Years	Brief description
Pre-methodology	From 1960s to 1970s	Computer applications were developed without explicit or formalized methodologies. The development, to a great extent, depends on individual programmers' experience and expertise.
Early-methodology	From late 1970s to early 1980s	To improve the management of ISD and introduce discipline, important phases and stages of ISD were identified. A dominant ISD approach during this era is the System Development Life Cycle (SDLC).
Methodology	From late 1980s to early 1990s	Numerous new approaches emerged in response to one or more limitations that are associated with SDLC approach. Tools supporting many methodologies were also developed. However, the proliferation of ISD methodologies and approaches is in contrast with their sluggish adoption by organizations.
Post-methodology	From late 1990s to present	This era is characterized by a serious reappraisal of the usefulness of the earlier ISD methodologies. Some organizations turned to yet different methodologies and approaches, while others abandoned methodologies altogether.

The history indicates that after initial wide adoptions, ISD methodologies are at a critical junction. Serious appraisals of the usefulness of the earlier ISD methodologies are necessary for organizations to make informed decisions about ISD methodology adoption and usage.

PRIOR WORK ON EVALUATION OF ISD METHODOLOGIES

The main focus of prior ISD methodologies research was on the development of new ISD methodologies, and on frameworks for selecting and understanding methodologies. Research on methodologies evaluation and comparison has been lacking [Wynekoop and Russo, 1993,

Wynekoop and Russo, 1995]. Avison and Fitzgerald [2003b, p.79] point out the “danger of returning to the bad old days of the pre-methodology era and its lack of control, standards, and training”. They argue for the need to conduct more systematic evaluation on ISD methodologies.

One of the earliest attempts to evaluate and compare ISD methodologies was the CRIS (Comparative Review of Information Systems Design Methodologies) series of conferences [Olle et al., 1983, Olle et al., 1982, Olle et al., 1986]. The CRIS series attempted to examine methodologies by requesting inventors of methodologies to apply them to a common case. A feature comparison was conducted to identify commonalities and differences among methodologies. Notwithstanding the contributions made by the CRIS series, the endeavor failed to resolve many of the issues that they set out to achieve. Thus the conferences were not influential among practitioners. Iivari et al. [2000] point out that the CRIS series failed for two reasons.

1. No systematic conceptual framework was available at that time to make sense of the continuing proliferation of new ISD methodologies.

2. An excessive focus on detailed and complex conceptual artifacts is not appropriate.

Some field studies were conducted to evaluate selected ISD methodologies in the natural settings. For example, Edwards, Thompson, and Smith [1989a, 1989b] conducted a series of field studies to assess the satisfaction level of Structured Systems Analysis and Design Method (SSADM) users. Dekleva [1992] surveyed practitioners in 122 organizations in an effort to evaluate the benefits of modern ISD methodologies from the perspective of systems maintenance. More recently, Grant and Ngwenyama [2003] reported on an action research study that evaluated the usefulness of a manufacturing information systems development methodology at a manufacturing technology company. While the findings of these field studies may shed some light on the usefulness and effectiveness of certain ISD methodologies, each of these evaluations was based on different evaluation criteria and thus cannot be aggregated to form concrete conclusions.

Many studies are based on conceptual analysis and evaluation of ISD methodologies. For example, Nielson [1989], Klein and Hirschheim [1991], and Avison and Fitzgerald [1995] take a similar approach by discussing the strengths and weaknesses of select methodologies according to the criteria that they deem as important. Because of the inevitable variances in view toward and experience with ISD methodologies, these criteria greatly differ from one another. For example, BjØrn-Anderson [1984] identifies a checklist that includes criteria relating to values and society. Jayaranta [1994] proposes an evaluation framework called NIMSAD (Normative Information Model-based Systems Analysis and Design) based on the models and epistemology of systems thinking. The use of different evaluation criteria can result in "apples and oranges" comparisons in which the bases for the evaluation are dissimilar [Siau, 2004].

Many existing criteria or checklists also have operationalization issues. Some criteria are not operationalized as measurable scales. In other words, practitioners and researchers are unable to apply the criteria directly to measure ISD methodologies. Furthermore, the validity and reliability of some operationalized criteria are unknown, which cast doubt on the evaluation results.

MOTIVATION OF OUR STUDY

The evaluation of ISD methodologies is of theoretical and practical importance [Jayaratna, 1994, Lyytinen and Robey, 1999, Olle et al., 1982, Siau and Rossi, 1998, Tolvanen et al., 1996, Wynekoop and Russo, 1995, Wynekoop and Russo, 1997]. Comprehensive and theoretically sound evaluation criteria can guide organizations when they try to choose an appropriate ISD methodology. In addition, the accumulated knowledge derived from the evaluation and comparison on existing ISD methodologies can enable practitioners and researchers to improve existing methodologies or design new ones.

The review of prior work presented in this Section highlights a gap in the literature, which must be filled in order to advance the research in this area. The gaps come from scattered field studies and surveys on evaluation of ISD methodologies and from empirical evaluations that are not based on the same set of criteria..

Even though some researchers proposed their own set of criteria for evaluating ISD methodologies [e.g., Avison and Fitzgerald, 1995, Klein and Hirschheim, 1991, Nielsen, 1989], researchers and practitioners find it difficult to decide which set to choose and use. It is also unclear whether the criteria developed in late 1980s and early 1990s can adequately reflect the emerging trends in ISD evolution, such as business process reengineering (BPR), agile development, Web applications, and object-orientation [Iivari et al., 2000].

Developing a set of generally acceptable, practically valid, and reliable criteria is a critical step toward developing a systematic process to evaluate ISD methodologies. Our study is an effort in this endeavor. By surveying the opinions of researchers and practitioners who are experienced with ISD methodologies, we were able to generate a comprehensive set of evaluation criteria. That alleviates the potential limitations of evaluation criteria that were proposed subjectively by just one or two individuals.

III. RESEARCH METHOD

In this study, we surveyed a group of researchers and practitioners on their opinion about the criteria that should be used for evaluating currently used ISD methodologies. The data was collected through a Web-based electronic brainstorming session. A systematic content analysis technique served as the guide for our data analysis.

DATA COLLECTION

The purpose of this study is to identify a comprehensive set of criteria for evaluating ISD methodologies. Special efforts were made to ensure that no important evaluation factors were overlooked. Surveying experts' opinion is a common method to reduce a particular individual's influence in deciding evaluation criteria. In evaluation research in other disciplines, this method is widely adopted [Hart et al., 2003, Hatush and Skitmore, 1997, Montoya-Weiss and Calantone, 1999, Trochim, 1996]. Our study follows this method by surveying our research subjects' opinion about the important and relevant criteria for ISD methodology evaluation.

PARTICIPANTS

To elicit participants for this study, several invitations were sent to experienced researchers and practitioners in systems analysis and design. In total, 28 participants took part in the Web-based electronic brainstorming session over a period of thirty days. Valacich and Dennis [1994] find that the point at which electronic brainstorming groups could noticeably outperform nominal groups was at around eight members. In another study [Gallupe et al., 1992], the researchers also found the superiority of large group size (six to twelve). Another study that adopted Web-based brainstorming [Trochim, 1996] used a group size of 25. The group size of twenty-eight subjects for our electronic brainstorming session can be considered large enough to generate a comprehensive list of evaluation criteria for ISD methodologies.

Four participants are practitioners. Fifteen participants are IS researchers. The nine other participants are both researchers in academia and consultants in industry. Therefore, the results reflect the mixed opinions of researchers and practitioners, consistent with the purpose of this study to generate a comprehensive set of evaluation criteria. Table 2 provides information on the participants' experience in IT and ISD methodologies. It is evident that our research participants were experienced in ISD methodologies. In addition, the participants were from various geographic regions: 13 participants were from North America, 11 from Europe, 3 from Asia/Pacifica, and 1 from South America. Diverse background in participants is recommended by

many researchers [e.g., Dennis and Valacich, 1993, Furnham, 2000, Nagasundaram and Dennis, 1993] to improve the quality of the resulting ideas from brainstorming.

Table 2. Participants' Experience with ISD Methodologies

Experience Description	Mean
Experience in information technology (in years)	14.4
Experience in development methodology (in years)	10.6
Experience with structured methodologies (in years)	9.6
Experience with object-oriented methodologies (in years)	4.9

ELECTRONIC BRAINSTORMING

Electronic brainstorming is a structured yet effective way to generate ideas about a problem domain [Dennis and Valacich, 1993, Gallupe et al., 1991, Gallupe and Cooper, 1993, Valacich and Dennis, 1994]. Electronic brainstorming is capable of overcoming the weaknesses and problems inherent to traditional (face-to-face) brainstorming, namely social loafing, evaluation apprehension, and production blocking [Gallupe et al., 1991]. Furthermore, synergy may come from the pool of ideas exchanged by participants in electronic brainstorming [Nagasundaram and Dennis, 1993]. In other words, the pool of ideas will stimulate participants to generate ideas that they would otherwise not produce [Dennis and Valacich, 1993].

The electronic brainstorming we applied in our study is a Web-based anonymous brainstorming session. Besides offering the advantages associated with electronic brainstorming, Web-based brainstorming enables participants with access to the Web to enter their inputs anywhere and anytime. A Web site was constructed for our study. The Web site provided continuous update to participants, and allowed participants to add new criteria online. All the inputs to the Web site are anonymous.

After a participant logged into the Web-based brainstorming session, he/she would be prompted to enter his/her demographic information if it was the first visit.

The main page of the brainstorming session (Figure 2) is divided into three sections. The first section specifies the problem domain. A definition of ISD methodologies based on [Avison and Fitzgerald, 2003a] is provided, followed by a list of common methodologies. The focus statement for generating criteria is operationalized in the form of this instruction to the participants: "In this brainstorming session, we will generate the criteria that should be used for evaluating information systems development methodologies."

The second section is the current list of generated criteria by all the participants. It is displayed in a table with two columns "criteria" and "description".

The third section is the area in which a participant may add a new criterion. The prompt for input is: "One specific criterion I believe we should include in the set of criteria for evaluating system development methodologies is ..." The prompt helps to assure that the set of criteria is "of a kind." The participant enters a name for the new criterion in a text box and a description for it in a text area. After he/she clicks the button "Add a new criterion," the new criterion is added into the set and displayed following the existing criteria.

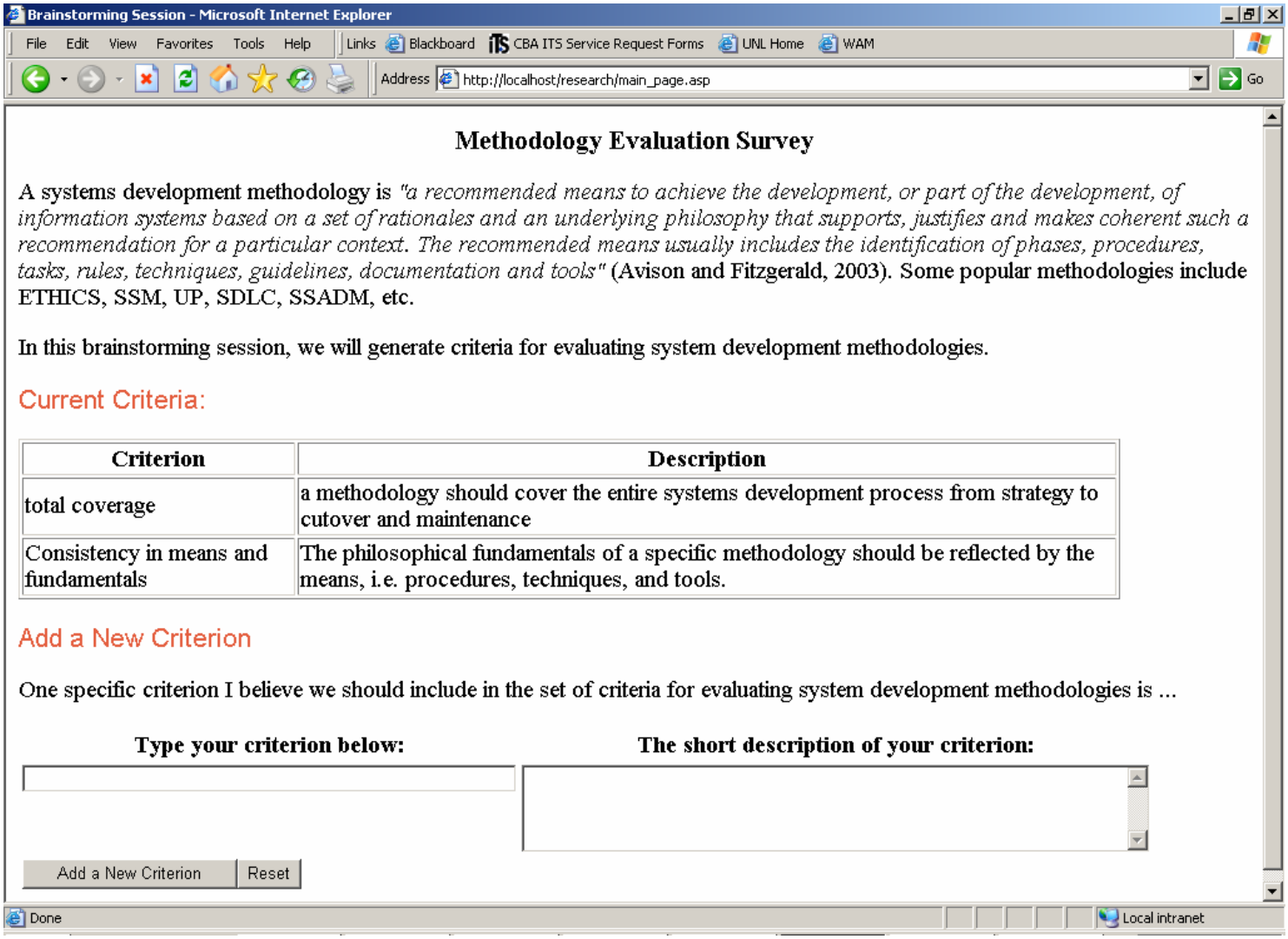

Figure 2. Screen Shot of the Main Brainstorming Web page

A Microsoft Access database was set up on the Web server to save all the information generated from the study. Every 24 hours, one of the authors would verify the normal operation status of the Web site. In addition, he would check the database to delete any erroneous, invalid, or duplicate entries. The Web site started operating on April 15, 2004 and was kept open for thirty days.

DATA ANALYSIS

The research participants developed 51 criteria over a one-month period. Our data analysis follows a systematic content analysis method outlined by Miles and Huberman [1994]. The purpose of data analysis is to enable us to present the findings more meaningfully. We conducted two rounds of content analysis on the generated criteria list. In the first round of content analysis, each author individually reviewed the whole list of criteria and identified irrelevant or overlapping entries. Through discussion and consensus, the two authors identified 32 unique criteria. The second round of content analysis grouped the individual criteria into more general categories. To reduce the subjectivity in this categorization process, we reviewed evaluation frameworks in the literature and conducted lengthy discussions to determine the relevant categories. In the end, we agreed on three general categories:

- methodology design
- methodology use
- methodology deliverables

RESEARCH RIGOR

A number of steps were taken to ensure the reliability and validity of the research results.

1. We applied a structured method – electronic brainstorming – to collect data. As a widely accepted method to generate ideas on a problem domain, electronic brainstorming enabled our research participants to identify the evaluation criteria as completely as possible. In view of the one-month duration of the electronic brainstorming session and the representativeness of the research participants, the resulting list of criteria can be regarded as reaching the "point of redundancy." In other words, the set of criteria is comprehensive such that no important evaluation factors were overlooked.

2. The research participants are experienced in information systems development yet diverse in background. Such a research sample, to a great extent, improves the comprehensiveness of the generated evaluation criteria and increases the generalizability of our research results.

3. A systematic content analysis technique guided our data analysis. Disagreements were resolved through discussions. Prior literature was used for supplemental validation. References to prior literature helped to validate the accuracy of the findings or show where the findings differ from the published literature [Creswell, 1998].

IV. FINDINGS AND DISCUSSIONS

In this section, we first report the findings of this study, i.e., the criteria identified for evaluating ISD methodologies. Then we discuss the research and practical implications of this study. Finally, we compare our findings with other evaluation frameworks.

FINDINGS

The three categories and the related individual criteria are shown in Table 3. Appendix I provides detailed descriptions of individual criteria. As discussed in Section III, the brainstormed criteria were classified into three categories – methodology design, methodology use, and methodology deliverables. We take the perspective that the three categories of criteria are not totally separated from one another. Instead, they represent means and goals of ISD methodologies. Methodology design properties are means to achieve the goals of effective and efficient methodology use, Such use will lead to the ultimate goals of methodology deliverables that meet the needs of users, projects and organizations.

Table 3. Categories of criteria for evaluating ISD methodologies

Category	Criterion
Methodology Design	Total coverage
	Consistency in means and fundamentals
	Having conflict resolution strategies between users
	Case Tool Support
	Take into account human cognition
	Take into account the social aspect
	Take into account organizational aspect
	Validation mechanisms
	Semantic Stability
	Formal foundation
	Support for Project Management
	Support for Project Management Team

	Communication
	Quality measurement criteria
	Modeling oriented
	Support group work
	Support for Creativity and Innovation
Methodology Use	Flexibility/adaptability
	Usability
	Agility
	Customizability
	Not vendor controlled
	Reasonably Priced
	Web enabled
	Reusability
	Continuous Evolution and Enhancement
	Easily mapped to development environments
Methodology Deliverables	High quality working system
	Produce understandable documentation
	Knowledge Base
	Organizational Memory
	Accessibility of documentation

PRACTICAL IMPLICATIONS

Choosing appropriate criteria for ISD methodology evaluation depends on distinguishing the different stages in systems development when evaluation can be performed. Jayaratna [1994] recommends that the evaluation of ISD methodologies should be conducted in three stages. Table 4 lists the stages and the relations between the stages and the three categories that were identified in this study.

Table 4. Relation of Stages and Categories

Stage	Time	Category	Use
1	Before a methodology is adopted	Methodology Design	Conceptual evaluation
2	During its use	Methodology Use	Empirical evaluation
3	After the intervention (use)	Methodology Deliverables	Assessment of success

Next, we discuss the criteria in each category in detail and suggest ways to apply the criteria in evaluation practice.

Criteria Relating to Methodology Design

Many of the criteria identified through the brainstorming session are related to the wide-ranging methodology design properties. The criteria range from philosophical aspects to considerations of social and human issues, and from project management to tools and techniques support. The majority of the criteria in this category can be found in the prior work of ISD methodology evaluation [Avison and Fitzgerald, 1995, Jayaratna, 1994, Klein and Hirschheim, 1991, Nielsen, 1989], such as total coverage, CASE tool support, and modeling orientation. Several other criteria reflect latest trends in information systems development. For example, “support for creativity and innovation” is concerned with business process innovation and reengineering in the process of developing information systems. Several criteria pertaining to social and human issues reflect the increasing awareness and consideration of social-technical interactions in information systems development.

The criteria in this category can be used to evaluate ISD methodologies conceptually. The majority of existing ISD methodology evaluation research perform conceptual evaluations before the ISD methodologies are adopted.

Criteria Relating to Methodology Use

Rote implementation and a focus on following the procedures are considered to be the main problems in using ISD methodologies [Avison and Fitzgerald, 2003b, Wynekoop and Russo, 1995]. Many criteria regarding methodology use are concerned with flexibility, customizability, and adaptability of ISD methodologies. In addition, usability (easy to learn and easy to use) is another important criterion because users of ISD methodologies often complain about excessive overhead in training [Tolvanen et al., 1996]. Economic considerations are also included in this category. A methodology should not be controlled by a single vendor, leading to expensive adoption. Finally, some criteria reflect the latest trends, such as agile development, and Web enabled work environments.

The criteria listed in this category are suitable for evaluating ISD methodologies during their use. Experience of actually applying the methodology to realistic cases is able to provide insights into the methodology use. Therefore, the evaluation in this stage is primarily empirical investigations, which should be guided by the criteria in the second category. The empirical studies can be based on case studies or action research.

Criteria Relating to Methodology Deliverables

The ultimate goal of ISD methodologies is to produce high-quality working systems. This goal is recognized by both researchers and practitioners, and used as a means to evaluate ISD methodologies. Another common deliverable is documentation, which should ideally be easy to access and understand by various stakeholders. In this research, we also identified criteria dealing with knowledge gained and organizational memory as implicit deliverables from the use of ISD methodologies. They are not extensively addressed in prior work.

The criteria in this category are appropriate for *post hoc* evaluation of ISD methodologies. That is, such evaluations can be conducted after the methodologies are used. Empirical investigations are the primary form of evaluation in this stage. For example, a survey method can be applied to evaluate specific ISD methodologies based on the criteria relating to methodology deliverables. The evaluation of methodology deliverables can also be conducted in conjunction with the evaluation of methodology use in case studies or action research.

In summary, the evaluation of ISD methodologies is a complex task. In the evaluation process, we must apply appropriate criteria depending on the stage when the evaluation is performed.

RESEARCH IMPLICATIONS

The findings of this study offer significant implications for research in ISD methodologies evaluation and comparison.

1. The empirically generated evaluation criteria support the assertion that we must apply appropriate criteria depending on the ISD stage. Prior research in ISD methodology evaluation focuses primarily on design properties. The findings of this study show that methodology use and deliverables are also relevant, if not as important, in evaluating ISD methodologies. More empirical studies are needed about design properties, use, and deliverables.

2. The findings of this study suggest research opportunities. For instance, specific questionnaires can be designed to operationalize the criteria identified. Quantitative studies such as large scale surveys can be applied to determine the uniqueness of each criterion, similar to the notion of construct validity.

3. Field studies such as action research and case studies can be applied to investigate whether the list of evaluation criteria identified in this research is comprehensive. In addition, not all criteria are equally important. And the perceptions of the relative importance of each criterion are expected to differ among ISD methodology stakeholders. Empirical studies are needed to determine the set of key or core criteria, and to investigate the alternative perceptions.

COMPARISON WITH OTHER EVALUATION FRAMEWORKS

Catchpole [1987] summarizes the views of different researchers about the important criteria for comparing ISD methodologies, such as total coverage, separation of logical and physical designs, inter-stage communication, and increased productivity. Later, other criteria, such as separation of analysis and design, were suggested to be added to this list [Avison and Fitzgerald, 1995, Fitzgerald, 1990]. Some researchers suggest including a broader range of issues that are relevant in ISD methodology comparison. For example, Jayaranta [1994] proposes an evaluation framework called NIMSAD (Normative Information Model-based Systems Analysis and Design) to include the methodology context and user, besides the methodology itself, in methodology evaluation. Avison and Fitzgerald [1995] offer their own set of comparison criteria and propose a framework for comparing ISD methodologies. Since it includes a relevant and defensible set of features that have stood the test of time, we compare the findings of this study with the framework proposed by Avison and Fitzgerald [1995].

Avison and Fitzgerald's [1995] framework consists of seven basic elements or categories, namely philosophy, model, techniques and tools, scope, outputs, practice, and product. These authors state that the framework is not supposed to be fully comprehensive, missing some features such as the speed at which systems can be developed, the quantity of the specifications and documentation produced, and the potential for modification by users to suit their own environment. These missing features in Avison and Fitzgerald's [1995] framework can be found in the generated list of criteria in our study. For example, agility corresponds to the development speed; customizability is directly related to the potential for modification; and accessibility of documentation is associated with specifications and documentation produced. This equivalence suggests that the list of criteria identified in the present study is fairly comprehensive and is an extension of Avison and Fitzgerald's [1995] framework.

Avison and Fitzgerald's [1995] framework consists of components for evaluating the merits of ISD methodologies and for understanding ISD methodologies. For example, Avison and Fitzgerald explain, in great detail the philosophical underpinnings of ISD methodologies. While philosophical aspects are increasingly recognized as a critical issue for understanding ISD methodologies [Hirschheim et al., 1995, Iivari et al., 1998, Lyytinen, 1989], they are difficult to use when evaluating specific ISD methodologies. For example, it is difficult for evaluators to argue that one methodology is superior to another because of its realism orientation. The elements in their practice category, such as methodology background and user base, face the same aforementioned problem. As such, it is difficult to operationalize all components of Avison and Fitzgerald's [1995] framework for evaluation purposes. The criteria generated in the present study focus on evaluating ISD methodologies, and, therefore, can be operationalized using questionnaires. This is not to say that the philosophical underpinnings of ISD methodologies are not useful. The advantage of Avison and Fitzgerald's [1995] framework is that it includes philosophical underpinnings of ISD. Our list of criteria has the advantage of being easily operationalizable.

Avison and Fitzgerald's [1995] framework hints at the importance of outputs from methodologies, without providing specific and operationalizable criteria. In the present study, the criteria in the methodology deliverables category cover various aspects of the outputs of methodologies, ranging from documentation to resulting information systems.

Even though Avison and Fitzgerald's [1995] framework covers aspects of ISD methodologies, evaluators using the framework are not given guidelines on what criteria to use in different

evaluation stages. In the present study, the categorization explicitly indicates what criteria can be used before, during, or after methodology use.

V. CONCLUSION

The evaluation of ISD methodologies is becoming increasingly important in a world where hundreds, if not thousands, of differing methodologies claim the similar promises of wide applicability and overall usefulness.

This study is a step toward developing a systematic process to evaluate ISD methodologies. Like any other study, this study has its share of limitations. First, as pointed out by Avison and Fitzgerald [1995], all evaluations are subjective in nature and the choice of methodology evaluation framework is a value-laden task. In the present study, it is impossible to totally exclude the impacts of research participants' and researchers' subjectivity. Research methods can be applied to reduce the problem caused by the limitation of one's view toward and experience with ISD methodologies. In our study, we adopted a Web-based anonymous brainstorming method to survey the opinions of a group of experienced IS researchers and practitioners. In data analysis, we followed a systematic content analysis technique, extensively reviewed relevant literature, and resolved inconsistency through in-depth discussions. Second, the criteria identified in this study may partially overlap with each other, or closely relate to one another. Future studies applying quantitative research methods are needed to refine the list.

Our study makes both theoretical and practical contributions. For researchers, our study represents a step to developing a systematic process for evaluating ISD methodologies. The three categories of evaluation criteria – methodology design, methodology use, and methodology deliverables – are related to means and goals of ISD methodologies. A systematic evaluation framework may be built from our findings. For practitioners, our findings provide a set of evaluation criteria that are not subjectively derived by one or two persons.

Editor's Note: This paper is one in a series of articles in the Research in Information Systems Analysis and Design series, guest edited by Juhani Iivari and Jeffrey Parsons. Alan Hevner served as the CAIS departmental editor for the series. Some of the papers in this series are being published in JAIS and some in CAIS; the choice depending on the topic and approach of the paper. This paper was received on March 1, 2005. It was with the author for 2 revisions and was published on December 8, 2005.

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APPENDIX I. DESCRIPTIONS OF INDIVIDUAL CRITERIA

Criterion	Description
Total coverage	a methodology should cover the entire systems development process from strategy to cutover and maintenance
Consistency in means and fundamentals	The philosophical fundamentals of a specific methodology should be reflected by the means, i.e. procedures, techniques, and tools.
Having conflict resolution strategies between users	Almost All organizational information systems are opposed by at least a subset of users. How do we resolve this? A methodology with a formal mechanism to resolve this would be useful.
Case Tool Support	It is preferable to have CASE tool support for the methodology.
Take into account human cognition	Human cognition and limitations should be recognized in the methodology
Take into account the social aspect	Software development is usually a team effort. Team and group issues should be recognized and addressed
Take into account organizational aspect	Information systems are developed for an organization. The organization dynamics and issues should be able to be captured and reflected using the methodology.
Validation mechanisms	Include ways to validate the correctness of the model with the domain expert (e.g., ORM uses techniques such as verbalization and population for this purpose)
Semantic Stability	Models and systems built around them should be minimally impacted by changes to the business domain that do not alter the meaning of existing semantic structures.
Formal foundation	Models should be unambiguous, and formally grounded. Wherever possible the models should be executable.

Support for Project Management	A methodology should support management of the IS/IT project, identifying milestones, generating reports and documentations, etc .
Support for Project Management Team	Should support a team of project managers and analysts in using the methodology including communication support, conflict analysis, schedule conflict analysis.
Communication	Facilitate and support communication process among various stakeholders
Quality measurement criteria	The methodology should provide a list of quality measurement criteria for the input, procedure (process) and output of software development.
Modeling oriented	In ISD, we need to represent and communicate knowledge, which in many (not all) cases are best done using modeling techniques
Support group work	The majority of systems are developed by groups instead of standalone individuals. How the methodology best leverage group wisdom is a key.
Support for Creativity and Innovation	The methodology should provide and support techniques (e.g., brainstorming) for business process innovation and reengineering.
Flexibility/adaptability	The methodology can be tailored according to different development contexts, such as Web systems and enterprise applications integration. Systems development methodologies must be able to adjust to changing technologies and management needs.
Usability	The developer/designer should not be encumbered by excessively burdensome rules. The methodology should help the developer/designer to specify and develop what he/she wants without the developer/designer having to go through hoops.
Agility	Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
Customizability	Should be able to customize the methodology based on the size, type, etc. of the project
Not vendor controlled	The methodology should not be controlled by a single vendor.
Reasonably Priced	It should not be too expensive
Web enabled	Should be able to use over the Internet or even the wireless domain -- both synchronous and asynchronous support for management team
Reusability	Parts of the method should be reusable in other methods or projects
Continuous Evolution and Enhancement	The methodology should be enhanced and extended all the time -- getting better and better.
Easily mapped to development environments	While the methodology should be independent of particular programming languages or environments, it should be easy to relate the output to popular development environments and facilitate communication with developers.
High quality working system	The methodology should lead to the production of high quality working systems.
Produce understandable documentation	It should be possible for the user (NOT the developer) to easily understand the documentation produced. The documentation should help the user pinpoint potential problems. This means that a minimum of explication/training should be required to understand what documentation says.
Knowledge Base	Provide a knowledge base of best practices
Organizational Memory	Help in capturing and sharing knowledge related to systems development and project management in the organization
Accessibility of documentation	The methodology must be well documented and the documentation must be easily accessible

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