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The Method Evaluation Model: A Theoretical Model for Validating Information Systems Design Methods

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Abstract

Information Systems (IS) design research tends to emphasise the development of new methods (normative research), while addressing the evaluation of methods in only a limited fashion. A possible reason for this is the philosophical and methodological problems involved in validating methods ("knowledge how") as opposed to theses ("knowledge that"). "Knowledge that" has been the major focus of scientific research, which is generally about establishing the truth of particular propositions (hypotheses). However an entirely different approach is required to validate methodological knowledge. This paper proposes a theoretical model and associated measurement instrument for evaluating IS design methods. The model is based on two previously unrelated areas of theory: the Technology Acceptance Model (TAM) from the IS success literature and Methodological Pragmatism from the philosophy of science. The resulting theoretical model combines two different but related dimensions of method "success": actual effectiveness and adoption in practice. The model is applicable to all types of IS design methods as well as methods used in other domains. A laboratory experiment and a field experiment are conducted to test the model. The paper also presents some interesting findings about the use of undergraduate students in experimental studies.

Keywords

IS design, evaluation, Technology Acceptance Model (TAM), requirements analysis, Entity Relationship Model, experimental research

1. Introduction

1.1 Validation of IS Design Methods†

IS design research tends to emphasise the development of new methods while addressing the use and evaluation of methods in only a limited fashion (Bubenko, 1986; Curtis, 1986; Fitzgerald, 1991; Westrup, 1993; Wynekoop & Russo, 1997; Moody & Shanks, 1998). Wynekoop and Russo (1997) conducted a review of IS design research published in the leading IS journals over the past three decades. The results of the analysis showed a heavy reliance on normative research, largely focusing on the development of new methods or modifications to existing methods. They concluded that there was a "lack of serious empirical research into the efficacy of methods in practice" and a "need for validation of methods in organisational contexts using real practitioners".

However the question of how to validate IS design methods is a problematic issue (e.g. Olle, Sol & Verrijn-Stuart, 1982; Olle, Sol & Tully, 1983; Ivari, 1986; Olle, Sol & Verrijn-Stuart, 1986; Fitzgerald, 1991; Weber, 1997; Wynekoop & Russo, 1997). There are inherent problems evaluating any methodology or design technique since there is typically no theory, no hypotheses, no experimental design and no data analysis to which traditional evaluation criteria can be applied (Weber, 1997).

1.2 Adoption of IS Design Methods

A number of authors have commented on the low level of adoption in practice of IS design methods published in the research literature (Bubenko, 1986; Galliers, 1994; Wynekoop & Russo, 1997; Avison, Lau, Myers & Nielsen, 1999; Moody & Shanks, 2002). Regardless of the potential benefits of IS design methods published, unless they are used in practice, these benefits cannot be realised. The issue of practitioner acceptance of methods is something which has been largely ignored in IS design research. However, usage is an important pragmatic measure of the "success" of a method and also of the impact of research on practice (Fitzgerald, 1991).

1.3 Objectives of this Paper

The lack of an underlying theoretical framework or "paradigm" is a barrier to effective research in many areas of IS research (Weber, 1987; 1997). In this respect, IS design research lags many other areas of IS research where well developed theoretical frameworks for evaluation now exist (e.g. Davis, 1989; De Lone & McLean, 1992). This paper proposes a theoretical model for validation of IS design methods, which is based on two areas of previously unrelated theory.

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† In this paper, the term "IS design method" is used in its broadest sense, and refers to complete methodologies or individual techniques used within the development lifecycle.

2. Theoretical Foundations

2.1 Methodological Pragmatism

A possible reason for the lack of validation of IS design methods is the philosophical and methodological problems involved in validating *methods* as opposed to *theses*. According to Rescher (1977), human knowledge consists of two types:

- *Theses* or "knowledge that": these define statements or assertions about the world.
- *Methods* or "knowledge how": these define ways of doing things.

"Knowledge that" or propositional knowledge has been the primary focus of scientific research, which is generally about establishing the truth of particular propositions (*hypotheses*). Rescher argues that an entirely different approach is required to validate methodological knowledge. The reason is that methods have no truth value, only *pragmatic value*—a method does not describe any external reality, so it cannot be true or false, only effective or ineffective. Unlike theses, methods cannot be established deductively from known facts or inductively from observations. The validity of a method can only be established by applicative success in practice. The objective of validation should not be to demonstrate that the method is "correct" but that it is rational practice to adopt the method based on its *pragmatic success*.

Pragmatic success is defined as "the efficiency and effectiveness with which a method achieves its objectives (O)". All methods are designed to improve performance of a task (Figure 1). Task performance can be improved in two ways:

- Efficiency improvement: by reducing effort required to complete the task
- Effectiveness: improving the quality of the result.

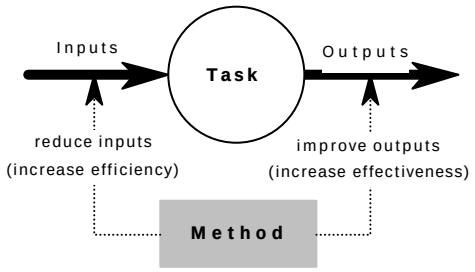

Figure 1. Efficiency vs Effectiveness

2.2 The Technology Acceptance Model (TAM)

User acceptance of information systems has become an important issue in the IS field (Davis, Bagozzi & Warshaw, 1989; Cooper & Zmud, 1990; Keen, 1991; Alavi & Carlson, 1992; Hartwick & Barki, 1994; Markus & Keil, 1994; Brancheau, Janz & Wetherbe, 1996; Gaynor, 1996; Hu & Chau, 1999). Regardless of the technical superiority or potential benefits of a particular information system, if it is not used or is under-utilised, the benefits cannot be realised (Chau, 1996). Of all the models that have been proposed for user technology acceptance, the Technology Acceptance Model (TAM) has been the most influential, and is one of the few candidates for a "paradigm" in the IS field. Compared to other models, TAM has

advantages in parsimony, IT specificity, strong theoretical basis and empirical support (Hu & Chau, 1999). There are three primary constructs in TAM (Davis et al, 1989):

- Perceived Ease of Use: "the degree to which a person believes that using a particular
- Perceived Usefulness: "a person's subjective probability that using a particular system would enhance his or her job performance".
- Intention to Use: "the extent to which a person intends to use a particular system"

All constructs of TAM are operationalised using multiple indicators. These were developed by synthesising previous measurement items from the literature and a rigorous process of evaluation of reliability and validity (Davis, 1989). TAM has been used as the theoretical basis for many empirical studies of user technology acceptance and has accumulated ample empirical support (Davis, 1989; Davis et al, 1989; Mathieson, 1991; Adams, Nelson & Todd, 1992; Taylor & Todd, 1995; Chau, 1996; Szajna, 1996; Hu & Chau, 1999).

There are clear parallels between user acceptance of information systems and practitioner adoption of methods. Both are subject to individual choice: users make decisions about what systems they will use and practitioners make decisions about what methods they will use. Both are therefore the result of reasoned action. For this reason, I argue that theoretical models used to explain and predict user acceptance of information technology may be adapted to explain and predict the adoption of methods.

3. A Theoretical Model for Evaluating IS Design Methods

3.1 In Search of the Dependent Variable: What Makes a "Successful" Method?

In deciding how to validate IS design methods, one of the central issues that needs to be resolved is to define the "dependent variable". That is, how do we determine whether a method is successful or not? This paper argues that there are (at least) two dimensions of "success" that need to be considered in evaluating IS design methods:

- Actual efficacy: whether the method improves performance of the task. This corresponds to Rescher's notion of pragmatic success.
- Adoption in practice: whether the method is used in practice. Regardless of whether the method improves performance or not, unless it is used in practice, its benefits cannot be realised.

On their own, neither actual efficacy nor adoption in practice will lead to improved practices. A method that improves performance but that is not used will have no effect on practices. Similarly, a method that people use but which reduces performance of the task will have a negative effect on practices.

3.2 The Method Evaluation Model

Figure 2 summarises the Method Evaluation Model, a theoretical model for evaluating methods which incorporates both aspects of method success discussed above. The diagram shows the primary constructs and causal relationships between them.

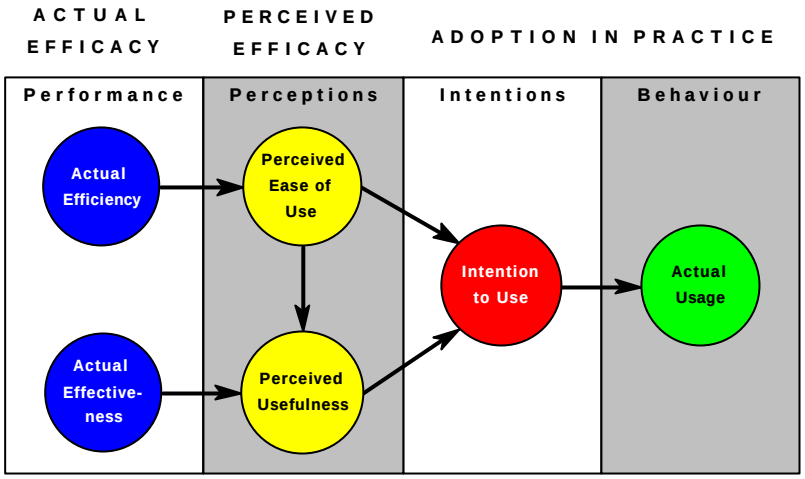

Figure 2. Method Evaluation Model

The constructs of the model are:

- Actual Efficiency: the effort required to apply a method.
- Actual Effectiveness: the degree to which a method achieves its objectives (O).
- Perceived Ease of Use: the degree to which a person believes that using a particular method would be free of effort.
- Perceived Usefulness: the degree to which a person believes that a particular method will be effective in achieving its intended objectives.
- Intention to Use: the extent to which a person intends to use a particular method.
- Actual Usage: the extent to which a method is used in practice.

Actual Efficiency and Actual Effectiveness are based on Rescher's concept of pragmatic success. Efficiency of a method is defined by the effort required to apply the method. This can be measured by a variety of *input measures*: time, cost or effort. Effectiveness of a method is defined by how well it achieves its objectives. This can be measured by evaluating the quantity and/or quality of the results (*output measures*).

The three central constructs of the model are the constructs of TAM. The definitions of the constructs have been modified to reflect the change of domain from systems to methods. The definition of Perceived Usefulness is also modified to reflect the fact that the effectiveness of a method can only be evaluated in the context of its objectives (Rescher, 1977). The constructs of TAM are sufficiently general that they can be translated to the methods domain.

3.3 Causal Relationships (Laws of Interaction)

The following causal relationships are hypothesised between the constructs of the model:

- Perceived Ease of Use is determined by Actual Efficiency. Actual Efficiency measures the effort required to apply the method, which should determine perceptions of effort required.
- Perceived Usefulness is determined by Actual Effectiveness. Actual Effectiveness measures how well the method achieves its objectives, which should determine perceptions of its effectiveness.
- Perceived Usefulness is determined by its Perceived Ease of Use. This follows from TAM.

- Intention to Use a method is jointly determined by its Perceived Ease of Use and Perceived Usefulness. This follows from TAM.
- Actual Usage of a method is determined by Intention to Use. This also follows from TAM.

Rescher's theory of Methodological Pragmatism predicts that methods that are more efficient and/or effective in achieving their objectives will be adopted in favour of other methods. This model proposes a slightly different view: that methods will be adopted based on *perceptions* of their ease of use and usefulness. Actual Efficiency and Effectiveness determine intentions to use a method only via perceptions of ease of use and usefulness. This is a subtle difference, but an important one—in human behaviour, *subjective reality* is more important than *objective reality.* While perceptions of ease of use and usefulness will be partly determined by actual efficacy, they will also be influenced by other factors (e.g. prior knowledge, experience with particular methods, normative influences).

3.4 Operationalisation of the Model

Measures for Actual Efficiency and Actual Effectiveness must be developed for each class of methods, based on their objectives (O) and the task being evaluated. There is no way to prescribe these apart from general guidelines about measures of time, cost and cognitive effort (efficiency), and quantity and quality of results (effectiveness). In the absence of any method-specific items for evaluating perceived efficacy, the items from TAM were used as a basis for formulating items for Perceived Ease of Use, Perceived Usefulness and Intention to Use. The wording of the items were changed to reflect the change of domain, and the items of Perceived Usefulness were modified to reflect the objectives of the method (O).

4. Laboratory Experiment: Comparative Evaluation of Large Data Model Representation Methods

A laboratory experiment was conducted in which the Method Evaluation Model was used to evaluate the comparative efficacy of a number of alternative methods for representing large data models (Moody, 2001).

4.1 Research Design

There were 41 participants in this experiment, all of whom were final year Information Systems students—these were used as proxies for analysts. Participants were randomly assigned to three treatment groups and were trained in one of the methods being evaluated. They were then given an example data model and asked to document the model using the method they had learnt. Finally, they were asked to complete a post-task survey, in which they were asked give their perceptions of the method they had used.

4.2 Independent Variable

The independent variable had three levels, corresponding to the methods being compared:

- Clustered Entity Models (Feldman & Miller, 1986)
- Structured Data Models (Simsion, 1989)

- Levelled Data Models (Moody, 1997)

The objectives of these methods were to improve end user understanding of data models (O_1) and simplify documentation and maintenance of large data models (O_2). Only the second objective was evaluated as part of this experiment—the first objective was evaluated using a different experimental task and different sample population (Moody, 2001).

4.3 Dependent (Outcome) Variables

Two performance based dependent variables were used to evaluate the methods:

- D1: Documentation Efficiency. This construct was measured by the time taken to complete the documentation task. This provides a measure of Actual Efficiency.
- D2: Clustering Consistency. This was measured by the number of clusters produced by each participant expressed as a percentage difference from the mean for the group. This provides a measure of consistency between different people using the method.

Three perception based variables were used to evaluate the methods:

- D3: Perceived Ease of Use. This was measured using six items on the post-task survey (Questions 1, 4, 5, 9, 11 and 14). Items used to operationalise Perceived Ease Of Use were adapted from Davis et al's (1989) study, with changes in wording to fit use of a method as opposed to use of a computer system. A total of six items were used to measure Perceived Ease of Use (the same number as in TAM). The TAM item from which each item is derived is shown in brackets after each item. Note that half the items in the survey are negated to avoid monotonous responses

  Q1. I found the procedure for applying the method complex and difficult to follow (PEOU1)
  Q4. Overall, I found the method difficult to use (PEOU2)
  Q6. I found the method easy to learn (PEOU3)
  Q9. I found it difficult to apply the method to the example data model (PEOU3)
  Q11. I found the rules of the method clear and easy to understand (PEOU5)
  Q14. I am not confident that I am now competent to apply this method in practice (PEOU6)

- D4: Perceived Usefulness. This was measured using eight items on the post-task survey (Questions 2, 3, 6, 7, 8, 12, 13, 15). The items used to operationalise Perceived Usefulness were adapted from Davis et al's (1989) study, with changes in wording to fit use of a method as opposed to use of a computer system, and to reflect the objectives of the method (as usefulness is defined in terms of how the method achieves its objectives).

  Q2. I believe that this method would reduce the effort required to document large data models (PU1)
  Q3. Large data models represented using this method would be more difficult for users to understand (PU4)
  Q5. This method would make it easier for users to verify whether data models are correct (PU4)
  Q7. Overall, I found the method to be useful (PU4)
  Q8. Using this method would make it more difficult to maintain large data models (PU5)
  Q12. Overall, I think this method does <u>not</u> provide an effective solution to the problem of representing large data models (PU6)
  Q15. Overall, I think this method is an improvement to the standard Entity Relationship Model (PU4)
  Q13. Using this method would make it easier to communicate large data models to end users (PU5)

- D5: Intention to Use. This was measured using two items on the post-task survey (Q10 and Q16). Statements used to operationalise Intention to Use were adapted from Davis et al's (1989) study. Intention To Use is operationalised using two items (the same number as used in TAM):

  Q10. I would definitely <u>not</u> use this method to document large Entity Relationship models (ITU1)

Q16. I intend to use this method in preference to the standard Entity Relationship Model if I have to work with large data models in the future (ITU1)

The items defined for Perceived Ease of Use, Perceived Usefulness and Intention to Use were combined together into a post-task survey consisting of 16 items. Each item was measured using a 5 point Likert scale, with negative statements on one side of the page and positive statements on the other side (opposing statements format). To ensure the balance of items in the questionnaire, half of the statements on the left hand side were negated to invite the attention of respondents who might become increasingly alert to manipulated question items (Hu & Chau, 1999). In addition, items were arranged in a random order to reduce the potential ceiling effect that could induce monotonous responses to question items measuring the same construct (Hu & Chau, 1999).

Actual Usage was not evaluated as part of this study, as this was not possible in an experimental context. However Davis et al (1989) found that intentions after only a one hour introduction to a computer package predicted usage behaviour 14 weeks later. In this experiment, participants spent two hours learning and using the methods, so we argue that intentions should predict future usage reasonably well.

4.4 Validity and Reliability Analysis

To evaluate the results for Perceived Ease of Use, Perceived Usefulness and Intention to Use, it is necessary first to evaluate the validity and reliability of their empirical indicators.

Construct Validity

Factor analysis is the preferred technique among researchers for evaluating construct validity. However in this experiment, the sample size was too small, so inter-item correlation analysis was carried out instead. Q13 (Perceived Usefulness) was found to have low convergent validity, and was therefore removed from the analysis.

Reliability

Reliability analysis was conducted on the items used to measure Perceived Ease of Use, Perceived Usefulness and Intention to Use (excluding Item 13). High levels of reliability were found for all constructs, with Cronbach's alpha > .8 in all cases (Table 1). This means that more than 80% of the variation is systematic rather than due to measurement error. While there is no definitive standard for reliability, alphas of 0.7 or above are considered to be acceptable in the literature (Nunally, 1978).

Table 1. Item Reliabilities

CONSTRUCT	CRONBACH'S α
Perceived Ease of Use	.88
Perceived Usefulness	.85
Intention to Use	.83

4.5 Comparison of Methods

Table 2 summarises the results for all experimental groups on all dependent variables.

Table 2. Comparison of Experimental Groups

	EXPERIMENTAL GROUP		
DEPENDENT VARIABLE	Clustered Entity Model	Structured Data Model	Levelled Data Model
Documentation Time (in minutes)	95.39	71.34	55.96
Clustering Consistency (% variation)	30.77%	22.53%	2.04%
Perceived Ease of Use (score /5)	2.51	3.54	4.1
Perceived Usefulness (score /5)	2.93	3.29	3.82
Intention to Use (score /5)	2.69	3.18	3.61

10 out of 15 comparisons between groups yielded significant results. The Levelled Data Models group performed significantly better than the Clustered Entity Model group on all dependent variables, and better than the Structured Data Model group on three dependent variables (Documentation Time, Clustering Consistency and Perceived Ease of Use). The Structured Data Models group performed better than the Clustered Entity Model group on two dependent variables (Documentation Time and Perceived Ease of Use).

4.6 Likelihood of Adoption in Practice

Likelihood of adoption in practice was evaluated by comparing the values of Perceived Ease of Use, Perceived Usefulness and Intention to Use for each experimental group with the "zero point" of the measurement scale (3). This determines whether mean responses are significantly positive or negative. Table 3 summarises the results of the one sample t-tests. All comparisons were found to be significantly positive for the Levelled Data Models method, which suggests that it is highly likely to be adopted in practice. The only significant results for the other two methods were for Perceived Ease of Use. The Structured Data Model method was found to be easy to use while the Clustered Entity Model method was found to be difficult to use.

Table 3. Significance of Responses

QUESTION	Clustered Entity Model	Structured Data Model	Levelled Data Model
Perceived Ease of Use	**No (0.031)**	**Yes (0.033)**	**Yes (0.000)**
Perceived Usefulness	Undecided (0.834)	Undecided (0.103)	**Yes (0.002)**
Intention to Use	Undecided (0.337)	Undecided (0.455)	**Yes (0.041)**

4.7 Validation of Causal Relationships

The causal relationships hypothesised in the Method Evaluation Model were evaluated using regression analysis.

Documentation Efficiency ® Perceived Ease of Use

This follows from the relationship between Actual Efficiency and Perceived Ease of Use in the Method Evaluation Model. This regression was significant with $\alpha < .01$, which means that the relationship was strongly confirmed.

Perceived Ease of Use ® Perceived Usefulness

This regression was significant with $\alpha < .01$, which means that the relationship was confirmed.

Perceived Ease of Use + Perceived Usefulness ® Intention to Use

This regression was significant, with $\alpha < .01$. However the relationship between Perceived Ease of Use and Intention to Use was *not* statistically significant after controlling for the effects of Perceived Usefulness. This result is consistent with many of the empirical studies of TAM (Davis et al, 1989; Chau, 1996). The relationship between Perceived Usefulness and Intention to Use was found to be significant with $\alpha < .01$.

Effect of Documentation Efficiency on Perceived Usefulness and Intention to Use

According to the Method Evaluation Model, perceptions of efficacy (ease of use and usefulness) determine intentions to use a method. Actual efficacy is hypothesised to affect intentions to use only *via* perceptions. To test this assumption, regression analyses were carried out to determine the direct effect of Documentation Time on Perceived Usefulness and Intention to Use:

- The first regression showed that after controlling for Perceived Ease of Use, Documentation Efficiency had no significant effect on Perceived Usefulness. This confirms that it is a causal antecedent of Perceived Ease of Use rather than a direct or parallel determinant of Perceived Usefulness.
- The second regression showed that Documentation Efficiency had no significant effect on Intention to Use after controlling for Perceived Usefulness. This confirms that it only has an indirect effect on Intention to Use via Perceived Ease of Use and Perceived Usefulness.

This confirms the hypothesis in the Method Evaluation Model that actual efficiency of methods only plays an *indirect* role in method adoption, by influencing people's perceptions of ease of use.

5. Field Experiment: Practitioner Acceptance Testing

A field experiment was conducted using experienced practitioners to evaluate the likelihood of adoption of the most successful method in the laboratory experiment (Levelled Data Model). This provided a test of the Method Evaluation Model using a more representative sample population. It also provided a check on the external validity of the findings about the method's likelihood of adoption in practice.

5.1 Sample Population vs Target Population

In general, the population from which one selects subjects for an experiment should be representative of the population to which the researcher wishes to generalise results (Cooper & Schindler, 1998). Clearly, using undergraduate students to evaluate methods (as in the laboratory experiment) is not the same as using practitioners. Generalisability is a significant problem in laboratory experiments involving university students, and is one of the major limitations of experimental research in the social sciences (Babbie, 1998). However in general, causal relationships are believed to more generalisable across populations than specific characteristics (Pedhazur & Schmelkin, 1991). This is a distinction between the *values* of variables and *relationships* between them (Babbie, 1998).

This suggests that the findings about the *relative efficacy* of the methods in the laboratory experiment – which represent relationships between the independent and dependent variables – are generalisable to practitioners. We would also expect that the relationships between the dependent variables would hold in the target population. However we could have little confidence that the same values of the dependent variables (perceptions of ease of use, usefulness and intentions to use) would be found using practitioners. As a result, the conclusions about the likelihood of adoption in practice of the methods are open to question.

5.2 Research Design

In this study, a one group, post-test only design was used. Only the most successful method (Levelled Data Model) from the laboratory experiment was tested. There were 21 participants in the study, all of whom were experienced practitioners. They participated voluntarily in the experiment in response to an invitation by email. The average IT experience of the participants was 18.4 years and average data modelling experience was 10.2 years. Participants were first trained in the use of the method. They were then given an example ER Model and asked to apply the method to it. Finally, they were then asked to complete a post-task survey, in which they were asked to give their perceptions of the method.

Independent Variable

The independent variable (experimental treatment) was the method used to document the data model. In this experiment, it has only one level (Levelled Data Model).

Dependent Variables

The dependent variables were the perception-based variables of the Method Evaluation Model:

- D1: Perceived Ease Of Use
- D2: Perceived Usefulness
- D3: Intention To Use

The same measurement instrument (post task survey) was used as in the previous experiment. No performance based data was collected as part of this experiment as this is only meaningful in comparison between methods.

5.3 Validity and Reliability Analysis

Construct Validity

Inter-item correlation analysis was used to evaluate validity of the dependent variables. Two items failed the validity test: Q13 (Perceived Usefulness) and Q14 (Perceived Ease of Use) and were therefore removed from the analysis. Q13 also failed the validity analysis in the laboratory experiment, which suggests a systematic flaw in this item.

Reliability Analysis

Reliability analysis was conducted on the items on the post-task survey, excluding Items 13 and 14. High levels of reliability were found for all constructs, with Cronbach's alpha > 0.7 in all cases.

Table 4. Item Reliabilities for Dependent Variables

CONSTRUCT	CRONBACH'S α
Perceived Ease of Use	.75
Perceived Usefulness	.82
Intention to Use	.96

5.4 Likelihood of Adoption in Practice

One sample t-tests were conducted on the value of each construct to determine whether they were significantly different to the zero point of the scale (3). The values of all dependent variables were found to be significantly positive. This suggests that the method has a high likelihood of being adopted in practice.

Table 5. Results of Static Comparisons

DEPENDENT VARIABLE	MEAN	STDEV	SIGNIFICANCE
Perceived Ease of Use	4.64	0.43	**.000**
Perceived Usefulness	4.33	0.47	**.000**
Intention to Use	4.19	0.80	**.000**

5.5 Comparison to Laboratory Experiment Results

Significance tests were carried out between the values of the dependent variables in this experiment and for the corresponding group in the laboratory experiment (Treatment Group 3). Two out of three of the comparisons were significant (Table 6).

Table 6. Differences Between Laboratory Experiment and Field Experiment Results

CONSTRUCT	LABORATORY EXPERIMENT	FIELD EXPERIMENT	SIGNIFICANCE
Perceived Ease of Use	4.16	4.64	**.030**
Perceived Usefulness	3.82	4.33	**.040**
Intention to Use	3.61	4.19	(.080)

As shown in Table 6, the practitioners found the method to be easier to use than the students did ($\alpha < .05$). This confirmed our *a priori* hypothesis, as it was expected that experts would find learning a new method easier than novices. However the practitioners also perceived the method to be more useful than the students did, which was unexpected ($\alpha < .05$). While one might expect practitioners to be harsher judges of the usefulness of a method than students, the explanation may be that the students were simply more conservative in making their judgements. Studies of decision making show that when people are uncertain in their judgements (either through lack of information or experience), they are less likely to make extreme choices (Simon, 1977). This results in a *centralising tendency* in their responses. No difference was found between the two experiments in participants' intentions to use the proposed method.

5.6 Validation of Causal Relationships

The causal relationships between dependent variables were investigated using regression analysis.

Perceived Ease of Use ® Perceived Usefulness

The regression equation obtained in this analysis was almost identical to that found in the laboratory experiment. This confirms the assumption in the literature that relationships between variables are generalisable between populations. Even though the *values* of Perceived Usefulness and Perceived Ease of Use were found to be significantly different, the *relationship* between the variables is almost identical.

Perceived Ease of Use + Perceived Usefulness ® Intention to Use

The regression equation obtained in this analysis was very different to the one found in the laboratory experiment. In this experiment, both independent variables had similar effects on Intention to Use (based on the beta-values), while in the laboratory experiment the effect of Perceived Usefulness was about three times that of Perceived Ease of Use. The regression was found to be highly significant, with $\alpha < .01$.

The relationship between Perceived Ease of Use and Intention to Use was found to be significant with $\alpha < .05$. This is consistent with the theoretical model, but contradicts the findings of the laboratory experiment. The relationship between Perceived Usefulness and Intention to Use was also significant with $\alpha < .05$. This is consistent with the theoretical model and the findings of the laboratory experiment. This suggests that the relative importance of Perceived Ease of Use in making decisions about method adoption is much higher for practitioners than it is for undergraduate students. The likely explanation for this is that practitioners have a high level of investment in existing methods, so that the cost of adopting a new method will be higher than for novices. Since Perceived Ease of Use represents a perceptual measure of the costs of adopting a new method, this is likely to play a much more important role in adoption decisions for practitioners.

6. Conclusion

IS design research tends to emphasise the development of new methods while addressing the use and evaluation of methods in only a limited fashion. One possible reason for this is the lack of a suitable theoretical framework for evaluating methods. This paper has defined a theoretical model for validating IS design methods. The model incorporates two distinct dimensions of method "success": actual efficacy and adoption in practice. It recognises that for a method to be successful, it not only has to improve task performance, but also that people need to be willing to use it. The paper illustrates how the model can be used to compare the efficacy of different methods (laboratory experiment) and also to evaluate the likelihood of adoption of a method in isolation (field experiment).

6.1 A Change in Focus for IS Design Research?

The issue of practitioner acceptance of methods is something which has been largely ignored in IS design research. However, usage is an important pragmatic measure of the "success" of a method and also of the impact of research on practice. This paper argues for a change in focus of IS design research. As well as trying to develop methods which produce better results, it is equally important to develop methods that people are *willing to use*. Regardless of the technical or theoretical superiority of a particular method, it cannot result in improved practices unless people use it. This is a lesson that has been well learnt in the IS success literature (Davis et al, 1989). If IS design research is to become more than just an academic exercise, researchers need to urgently address the issue of practitioner acceptance. Understanding the factors which determine method acceptance will help to reduce the gap between research and practice in IS design, and improve the uptake of methods in practice, which up until now has been very low.

6.2 On Laboratory Experimentation Using Undergraduate Students

The controversy over using college students in experimental research has been a topic of philosophical discourse and empirical investigation in many disciplines (e.g. Ashton & Kramer, 1980; Gordon, Slade & Schmidtt, 1986; 1987; Greenberg, 1987; McAulay, King & Carr, 1998). Gordon et al (1986) found that in the majority of studies in which students and non-students participated under identical conditions, experimental results were significantly different. This experiment confirms these findings: the values of two out of three dependent

variables were significantly different between the two experiments. This suggests that caution should be exercised in generalising from the results of experiments involving undergraduate students.

The literature also suggests that generalisations may be more safely drawn about relationships between variables than about absolute values (Pedhazur & Schmelkin, 1991; Babbie, 1998). However while two relationships between variables were almost identical between the two experiments, the other (Perceived Ease of Use → Intention to Use) was significantly different. This provides mixed support for the generalisability of relationships between populations.

The results of the experiments also suggest that the effort required to get practitioners to participate in experiments may be worthwhile, as it can increase both the external validity and statistical significance of results. If students, because of their limited knowledge and experience, tend to make conservative judgements on perception-based variables, this will tend to reduce differences between groups and therefore the significance of results.

References

1. ADAMS, M., NELSON, R.R. and TODD, P.A. (1992): "Perceived Usefulness, Ease of Use and Usage of Information Technology: A Replication", *MIS Quarterly*, **16**, 2, pp. 227-247, June.
2. ALAVI, M. and CARLSON, P. (1992): "A Review of MIS Research and Disciplinary Development", *Journal of Management Information Systems*, **8**, 4, pp. 45-62, Spring.
3. ASHTON, R.H. and KRAMER, S.S. (1980): "Students as Surrogates in Behavioral Accounting Research: Some Evidence", *Journal of Accounting Research*, pp. 1-13, Spring.
4. AVISON, D., LAU, F., MYERS, M. and NIELSEN, P.A. (1999): "Action Research", *Communications of the ACM*, **42**, 1, January.
5. BABBIE, E.R. (1998): *The Practice of Social Research*, Wadsworth Publishing, Belmont, California.
6. BRANCHEAU, J.C., JANZ, B.D. and WETHERBE, J.C. (1996): "Key Issues in Information Systems Management", *MIS Quarterly*, **20**, 2, pp. 225-242, June.
7. BUBENKO, J.A. (1986): "Information Systems Methodologies - A Research View". *Information Systems Design Methodologies: Improving The Practice*, T.W. Olle, H.G. Sol and A.A. Verrijn-Stuart, (Eds.), North-Holland.
8. CHAU, P.Y.K. (1996): "An Empirical Assessment of a Modified Technology Acceptance Model", *Journal of Management Information Systems*, **13**, 2.
9. COOPER, D.R. and SCHINDLER, P.S. (1998): *Business Research Methods (6th edition)*, McGraw-Hill International, Singapore.
10. COOPER, R.B. and ZMUD, R.W. (1990): "Information Technology Implementation: A Technological Diffusion Approach", *Management Science*, **36**, 2, pp. 156-172, February.
11. CURTIS, B. (1986): "By The Way, Did Anyone Study Any Real Programmers?". *Empirical Studies of Programmers*, E. Soloway and S. Iyengar, (Eds.), Norward, N.J., Ablex.
12. DAVIS, F.D. (1989): "Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information Technology", *MIS Quarterly*, **13**, 3.

13. DAVIS, F.D., BAGOZZI, R.P. and WARSHAW, P.R. (1989): "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models", *Management Science*, **35**, 8, pp. 982-1003.

14. DE LONE, W.H. and MCLEAN, E.R. (1992): "The Quest for the Dependent Variable", *Information Systems Research*, **3**, 1.

15. FELDMAN, P. and MILLER, D. (1986): "Entity Model Clustering: Structuring A Data Model By Abstraction", *The Computer Journal*, **29**, 4.

16. FITZGERALD, G. (1991): "Validating New Information Systems Techniques: A Retrospective Analysis", *Information Systems Research: Contemporary Approaches And Emergent Traditions*, H.E. Nissen, H.K. Klein and R. Hirschheim, (Eds.), North-Holland,

17. GALLIERS, R.D. (1994): "Relevance and Rigour in Information Systems Research: Some Personal Reflections on Issues Facing the Information Systems Research Community", *Proceedings of the IFIP TC8 Conference on Business Process Reengineering: Information Systems and Challenges*, Gold Coast, Australia,

18. GAYNOR, G.H. (Ed.) (1996): *Handbook of Technology Management*, McGraw-Hill, New York.

19. GORDON, M.E., SLADE, L.A. and SCHMIDTT, N. (1986): "The "Science of the Sophomore" Revisited: From Conjecture to Empiricism", *Academy of Management Review*, **11**, 1, pp. 191-207.

20. GORDON, M.E., SLADE, L.A. and SCHMIDTT, N. (1987): "Student Guinea Pigs: Porcine Predictors and Particularistic Phenomena", *Academy of Management Review*, **12**, 1, pp. 160-163.

21. GREENBERG, J. (1987): "The College Sophomore as Guinea Pig: Setting the Record Straight", *Academy of Management Review*, **12**, 1, pp. 157-159.

22. HARTWICK, J. and BARKI, H. (1994): "Explaining the Role of User Participation in Information Systems Use", *Management Science*, **40**, 4, pp. 440-465, April.

23. HU, P.J. and CHAU, P.Y.K. (1999): "Examining the Technology Acceptance Model Using Physician Acceptance of Telemedicine Technology", *Journal of Management Information Systems*, **16**, 2, pp. 91-113, Fall.

24. IVARI, J. (1986): "Dimensions Of Information Systems Design: A Framework For A Long Range Research Program", *Information Systems Journal*, June.

25. KEEN, P.G.W. (1991): *Shaping the Future: Business Design Through Information Technology*, Harvard Business School Press, Boston.

26. MARKUS, M.L. and KEIL, M. (1994): "If We Build It, They Will Come: Designing Information Systems That People Want to Use", *Sloan Management Review*, **35**, 4, pp. 11-25, Summer.

27. MATHIESON, K. (1991): "Predicting User Intention: Comparing the Technology Acceptance Model with the Theory of Planned Behaviour", *Information Systems Research*, **2**, 3, pp. 173-191, September.

28. MCAULAY, L., KING, M. and CARR, C. (1998): "Expertise and Learning:

29. An Alternative Perspective on the Theory-Practice Debate", *British Accounting Review*, **30**, 2, pp. 173-200.

30. MOODY, D.L. (1997): "A Multi-Level Architecture For Representing Enterprise Data Models", *Proceedings Of The Sixteenth International Conference On Conceptual Modelling (ER'97)*, D.W. Embley and R.C. Goldstein, (Eds.), Los Angeles, November 1-3.

31. MOODY, D.L. (2001): *Dealing with Complexity: A Practical Method for Representing Large Entity Relationship Models (PhD Thesis)*, Department Of Information Systems, University of Melbourne, Melbourne, Australia.

32. MOODY, D.L. and SHANKS, G.G. (1998): "Evaluating and Improving the Quality of Entity Relationship Models: An Action Research Programme", *Australian Computer Journal*, November.

33. MOODY, D.L. and SHANKS, G.G. (2002): "Improving the Quality of Data Models: Empirical Validation of a Quality Management Framework", *International Journal of Information Systems*, **forthcoming**.

34. NUNALLY, J. (1978): *Psychometric Theory (2nd edition)*, McGraw Hill, New York.

35. OLLE, T.W., SOL, H.G. and TULLY, C.J. (Eds.) (1983): *Information Systems Design Methodologies: A Feature Analysis*, North-Holland, Amsterdam.

36. OLLE, T.W., SOL, H.G. and VERRIJN-STUART, A.A. (Eds.) (1982): *Information Systems Design Methodologies: A Comparative Review*, North-Holland, Amsterdam.

37. OLLE, T.W., SOL, H.G. and VERRIJN-STUART, A.A. (Eds.) (1986): *Information Systems Design Methodologies: Improving the Practice*, North-Holland, Amsterdam.

38. PEDHAZUR, E.J. and SCHMELKIN, L.P. (1991): *Measurement, Design and Analysis: An Integrated Approach*, Lawrence Erlbaum Associates Inc, Hillsdale, NJ.

39. RESCHER, N. (1977): *Methodological Pragmatism: Systems-Theoretic Approach to the Theory of Knowledge*, Basil Blackwell, Oxford.

40. SIMON, H.A. (1977): *The New Science of Management Decision Making (revised edition)*, Prentice-Hall, Englewood Cliffs, NJ.

41. SIMSION, G.C. (1989): "A Structured Approach To Data Modelling", *The Australian Computer Journal*, August.

42. SZAJNA, B. (1996): "Empirical Evaluation of the Revised Technology Acceptance Model", *Information Systems Research*, **42**, 1, pp. 85-92, January.

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

44. WEBER, R.A. (1987): "Toward a Theory of Artifacts: A Paradigmatic Base for Information Systems Research", *Journal of Information Systems*, **1**, 2, Spring.

45. WEBER, R.A. (1997): *Ontological Foundations Of Information Systems*, Coopers And Lybrand Accounting Research Methodology Monograph No. 4, Coopers And Lybrand, Melbourne, Australia.

46. WESTRUP, C. (1993): "Information Systems Methodologies in Use", *Journal of Information Technology*, **8**.

47. WYNEKOOP, J.L. and RUSSO, N.L. (1997): "Studying Systems Development Methodologies: An Examination Of Research Methods", *Information Systems Journal*, **7**, 1, January.