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Using a General Task -Technology Fit Model to Assess Software Maintenance Tool Utilization

Mark T. Dishaw
University of Wisconsin- Oshkosh, dishaw@vaxa.cis.uwosh.edu

Diane M. Strong
Worcester Polytechnic Institute, dstrong@wpi.edu

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Introduction

The ability of information technology to support a task is expressed by a formal construct known as Task-Technology Fit, which is the matching of the capabilities of the technology to the demands of the task. This construct was developed from an assumption that information technology will be used if the functions available to the user support, or fit, the activities of the user. An information technology function supports an activity if it facilitates that activity. Alternatively stated, information technology must serve to lower the cost to the user of the performance of some task or action if it is to be used. Rational, experienced users choose those tools and methods which enable them to complete the task with the greatest net benefit. Information technologies which do not offer sufficient advantage will not be used (Dishaw and Strong 1996).

We use Goodhue's operationalization of the Task-Technology Fit construct (Goodhue 1992; Goodhue 1995) in a study of software maintenance tools. Specifically, we assess whether higher tool usage is associated with higher fit between maintenance support tools and software maintenance tasks.

Task - Technology Fit and Software Utilization

Task-Technology Fit

Goodhue's (1995) approach to fit addresses some of the well-known deficiencies in the user satisfaction construct (Melone 1990; Goodhue 1992; Goodhue 1995). The satisfaction construct uses affect as a determinant of behavior and ignores other rationally-held beliefs. For example, a person may not "like" or have positive feelings about a piece of software but may still use the software as it leads to a favorable job or task outcome. The task-technology fit construct captures a person's belief system regarding the possible outcomes of "task-system" fit which result from information technology use.

Independent Variables

Fit is the independent variable in the general form of Task-technology Fit models. Goodhue originally operationalized Fit in the context of accessing quantitative data for use in managerial decision making. In this operationalization, Fit contains twelve dimensions: Accessibility, Assistance, Ease of Use, System Reliability, Accuracy, Compatibility, Currency, Presentation, Level of Confusion, Level of Detail, Meaning, and Locatability (Goodhue 1992; 1995). Definitions of these twelve variables are found in Goodhue (1992; 1995). This operationalization of Fit, with some minor changes, was shown in a later study to apply to more general contexts, any information technology in the systems environment of end users across many functional areas of two companies (Goodhue and Thompson 1995).

We use these twelve in our assessment of the fit between software maintenance tools and software maintenance tasks. While use of software maintenance tools by software maintainers may seem like a very different task context than access of data by managers, Goodhue demonstrated that his operationalization applies to many different information technologies, tasks, and users (Goodhue and Thompson 1995), although it was not tested specifically with IS tasks. Furthermore, the programs accessed and manipulated by maintainers play a similar role to data accessed and manipulated by managers. Thus, the dimensions of Fit for information technologies to access and manipulate data are likely to be similar to those for information technologies used to access and manipulate programs, at least at the general level of the dimensions used by Goodhue.

Dependent Variable

A Task-Technology Fit model is predicting that higher degrees of "Fit" lead to expectations by users of beneficial consequences of use (Goodhue 1992) and to higher performance (Goodhue 1988). The dependent variable in the models of fit is technology utilization, individual performance, or both. This study focuses on tool usage, the performance antecedent, as the dependent variable. Tool usage means the amount, extent, or frequency of tool use.

Since usage is closer to the independent variables in the causal chain than performance is, usage is commonly employed as the dependent variable in information technology success studies (Delone and McLean 1992). Utilization, however, is only appropriate when use is voluntary; otherwise, the most appropriate dependent variable is performance (Goodhue 1995). Before selecting utilization as our dependent variable, we verified that software maintenance tool use is voluntary in our subject organizations. Maintainers are not required to use these tools nor are the tools necessary for successful completion of their tasks.

Research Hypothesis (H_0): Higher task-technology fit is associated with higher use of tools.

Research Method

We operationalize Task-Technology Fit using the method described by Goodhue (1992; 1995), which measures fit through the twelve variables listed above. Goodhue's original questions for measuring these variables are found in Goodhue (1992; 1995). While

Goodhue's questions for measuring the twelve dimensions have been shown to apply across a wide range of tasks and information technologies, we made minor modifications in wording to reflect more closely our context of the maintenance tasks and the software tools which were available to maintainers.

The Goodhue instrument assumes that the perception of the user that a software tool is appropriate for a certain task represents "Fit" between task and technology. Thus, the instrument is a questionnaire capturing user perceptions.

Data for this study were collected in three organizations, an aerospace firm, an insurance company, and a financial services firm. Each organization had a similar systems environment both for applications and for information technologies for supporting maintenance. The unit of analysis is an individually-performed maintenance project. We collected data from maintainers for a total of 74 projects. Participation in the research was voluntary. Maintainers completed a questionnaire at the end of their project for all projects undertaken during the data collection period of approximately 6 weeks.

Scores for each variable were computed as the mean of the associated items. The following table presents the correlations and descriptive statistics for these variables. Note that Cronbach alpha is shown on the diagonal. All of the variables show acceptable alpha reliability, except for Data Reliability (12). This variable was excluded from further analysis.

		Items	mean	sd												
1.	Accessibility	3	3.865	2.084	.77	.	.	.	.	.	.	.	.	.	.	.
2.	Assistance	2	4.137	2.177	.826**	.85	.	.	.	.	.	.	.	.	.	.
3.	Accuracy	2	4.164	2.217	.556**	.452**	.76	.	.	.	.	.	.	.	.	.
4.	Compatibility	3	4.548	1.112	.451**	.212	.470**	.79	.	.	.	.	.	.	.	.
5.	Currency	3	3.919	2.174	.604**	.483**	.883**	.449**	.86	.	.	.	.	.	.	.
6.	Ease of Use	2	3.555	1.910	.525**	.503**	.586**	.082	.616**	.70	.	.	.	.	.	.
7.	Level of Detail	2	3.034	2.044	.697**	.693**	.615**	.172	.675**	.759**	.68	.	.	.	.	.
8.	Confusion	2	5.295	1.601	-.301*	-.290*	-.016	.299	-.022	-.171	-.155	.83	.	.	.	.
9.	Locatability	2	3.288	2.036	.854**	.771**	.380**	.381*	.508**	.472**	.654**	-.391**	.78	.	.	.
10.	Presentation	2	3.384	2.119	.703**	.658**	.761**	.118	.730**	.799**	.804**	-.221	.573**	.82	.	.
11.	Meaning	2	3.568	1.973	.589**	.540**	.835**	.268	.794**	.616**	.740**	-.115	.476**	.784**	.76	.
12.	Reliability	2	5.377	1.563	.048	.016	.143	.417*	.143	.094	.070	.327*	.043	.093	.160	.40

* - Signif. LE .05 ** - Signif. LE .01 (2-tailed)

Figure 1

Results

Eleven-variable Model

We tested our research hypothesis using regression. The dependent variable was tool use and the independent variables were the eleven dimensions of Fit. (System Reliability was dropped earlier due to its low Cronbach alpha.) The adjusted R^2 is very low (.03) and the regression is not significant (Signif F = .4278). In addition, the signs of the beta coefficients for the variables in the model are mixed. These results essentially replicate those of Goodhue and Thompson (1995, p. 229) who report an adjusted R2 of .02, significant at .05 for a sample of over 600 end users. They also reported a mix of positive and negative beta coefficients; two negative and one positive beta were significant. They posit that the negative betas are the result of feedback, i.e., utilization affects the perception of some TTF factors. The result might also be explained by other factors, such as poor Ease of Use (Dishaw 1994). For example, easily accessible tools may be those tools that maintainers do not use because they difficult to use.

Four-variable Model

The eleven correlated independent variables in the eleven-variable regression make the results difficult to interpret, as well as lowering the adjusted R^2. A potential solution to this problem is to consolidate the variables, provided we have a sound prior justification for doing so. Since these fit variables were originally operationalized in the context of data access and data use, we apply the hierarchical data quality framework of Wang and Strong (1996) to consolidate the variables. Since they define data quality as "fitness for use", their results are directly applicable to operationalizing Fit.

This data quality (DQ) framework consists of four higher level DQ categories formed by combining 15 lower level dimensions. The four categories are Intrinsic, Contextual, Representational, and Accessibility DQ (Wang and Strong 1996). Using the definitions of the Fit dimensions (Goodhue 1992; 1995), the twelve Fit dimensions map directly into the four categories, as shown in Figure 2. Scores for each new variable were computed as the mean of the items associated with the corresponding fit dimensions. Figure 2 also presents the correlations and Cronbach alphas (on the diagonal) for these new variables. All of the variables show acceptable alpha reliability, although Intrinsic DQ is lower than desirable.

DQ Category	FIT Dimensions	Int DQ	Cxt DQ	Rep DQ	Acc DQ
Intrinsic DQ	Accuracy, Reliability	.64			
Contextual DQ	Currency, Level of Detail	.53**	.73		
Representational DQ	Compatibility, Meaning, Presentation, Lack of Confusion	.58**	.87**	.80	

Accessibility DQ	Accessibility, Assistance, Ease of Use (of H/W & S/W), Locatability	.34**	.81**	.77**	.81

Figure 2

The regression of the consolidated Fit variables is shown below in Figure 3. The dependent variable is tool use and the independent variables are the four categories of DQ. The adjusted R^2 is now acceptable (.18) and the regression is significant at .004. The signs of the beta coefficients for the variables in the model are still mixed. Thus, while we can conclude the Fit is associated with utilization, higher fit does not always lead to higher utilization.

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Multiple R           .48292

R Square             .23322

Adjusted R Square    .17941
Standard Error      1.21672

Analysis of Variance
                    DF      Sum of Squares      Mean Square
Regression           4            25.66516          6.41629
Residual            57            84.38358          1.48041

F =       4.33412       Signif F =  .0040

Variable               B        SE B       Beta         T  Sig T

DQ_INT           .291052     .145243    .294230     2.004  .0498
DQ_CXT           .265274     .183310    .384404     1.447  .1533
DQ_REP         -.457625     .200104   -.578261    -2.287  .0259
DQ_ACC         -.244749     .157050   -.325644    -1.558  .1247

(Constant)     5.700831     .639501                 8.915  .0000
```

Figure 3

Conclusion

We have replicated and extended previous research on Task-Technology Fit by Goodhue (1988; 1992; 1995) and Goodhue and Thompson (1995). Our replication produces nearly identical results to that of previous work. Our extension using the data quality framework of Wang and Strong (1996) provides one possible approach for addressing the weak results between fit and utilization. However, more research is needed on the operationalization and measurement of Fit. In addition, some of the problems may be caused by the operationalization and measurement of the dependent variable in Task-

Technology Fit models, whether it is utilization or performance. MIS research, in general, has had difficulties in measuring outcomes (Delone and McLean 1992).

In summary, Task-Technology Fit is an important construct for understanding the utilization of information technology when users have the freedom to choose the software and determine the extent of utilization. While other factors clearly could play a part in determining utilization, an understanding of TTF is very important for tool builders in the creation of new information technology products.

The full description and results of this study are a part of a completed MIS doctoral dissertation (Dishaw 1994). References are available on request from the first author.