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Mihir Parikh
Polytechnic University

Bijan Fazlollahi
Georgia State University

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Mihir A. Parikh
Polytechnic University
mparikh@poly.edu

Bijan Fazlollahi
Georgia State University
bijan@gsu.edu

Abstract

User satisfaction, a subjective measure, is often substituted for system effectiveness, an objective measure, (and vice versa) in evaluating system success. This substitution is based upon the assumption that these two measures are conceptually and empirically interrelated. This study empirically examines this assumption by analyzing the relationships between user satisfaction and three system effectiveness measures in the context of decision support system. The study found that user satisfaction has weak relationship with system effectiveness and should not be substituted. To avoid an incomplete and potentially misleading evaluation of a DSS, researchers and managers should use both types of measures.

Introduction and Background

Decision support systems (DSS) in their role of supporting decision-makers represent an opportunity, not necessity as in the case of mission-critical transaction systems, for improving a decision-making process. Developing and using a new DSS or an innovative DSS feature involves significant, but optional, investment in time, cost, and effort as well as the potential risk of making wrong decisions because of the DSS. Therefore, managers or decision-makers should carefully evaluate new DSS and features to verify whether they are successful in their objectives or not.

System effectiveness is a widely used measure of system success (DeLone and McLean 1992; Gelderman 1998; Hamilton and Chervany 1981; Montazemi et al. 1996; Parikh et al. 2001; Wilson and Zigurs 1999). It is measured in terms on how well a system attains its design objectives such as improving decision quality, user learning, and/or decision efficiency. A system is a success when it achieves its pre-defined objectives. Another widely-used measure of system success is user satisfaction (DeLone and McLean 1992; Doll and Torkzadeh 1988; Ives et al. 1983; Mahmood et al. 2000; Melone 1990). User satisfaction measures users' attitude toward the system rather than the system's technical prowess (Ives et al. 1983). Because attitude leads to action, user satisfaction prompts user acceptance of the system and higher system usage (Baroudi et al. 1986; Davis et al. 1989; Doll and Torkzadeh 1988; Fishbein and Ajzen 1975; Iivari and Ervasti 1994). A system succeeds when its intended users use it as frequently as needed. (Iivari and Ervasti 1994).

User satisfaction is a perceptual or subjective measure, whereas system effectiveness is an objective measure. Some researchers suggest that user satisfaction can serve as a substitute for an objective measure in evaluating system success (Etezadi-Amoli and Farhoomand 1996; Gelderman 1998; Hubona and Cheney 1994; Ives et al. 1983), while some question this substitution (Gatian 1994; Goodhue et al. 2000; Hufnagel 1990). The argument for substitution is based on the notion that these subjective and objective measures are strongly interrelated. However, no previous study has analyzed this important relationship between user satisfaction and system effectiveness for DSS with deliberate decisional guidance, an optional feature introduced to improve DSS effectiveness.

Silver (1991) introduced the concept of *decisional guidance* in terms of how a DSS enlightens or sways its users as they structure and execute their decision-making processes. Decisional guidance can be deliberate or inadvertent. Deliberate decisional guidance is intentionally built in the system by its designers. Inadvertent decisional guidance is an unintended consequence of system design. When an objective of a DSS is to provide a broad range of functionalities, support multiple or changing decision-making environments, promote creativity, or foster exploratory learning, DSS designers favor less-restrictive system (Silver 1991).

However, such a system can confuse users as they choose among various functionalities and, in turn, reduce their ability to make effective decisions. Here, DSS designers may choose to design and build deliberate decisional guidance to guide users and reduce frustration and confusion associated with a less-restrictive system.

This study empirically examines the relationship between user satisfaction and system effectiveness in a DSS with decisional guidance. It employs a research model comprising six dimensions of user satisfaction, including relevance, confidence, usefulness, ease of use, format, and playfulness, and three measures of system effectiveness, decision quality, user learning, and decision time. The findings of this study are useful to DSS users, DSS designers, managers, and researchers. It can help answer many important questions, such as: Does satisfaction or dissatisfaction with decisional guidance interfere with a specific objective, such as improving decision quality or increasing user learning, for which decisional guidance is built? Should the designer deliberately build decisional guidance to support a specific objective? If a user is not satisfied with decisional guidance or a DSS, should the user abandon the system? Does lower user satisfaction mean lower performance or lower performance mean lower user satisfaction? Do the satisfied users learn more or unsatisfied users learn less? Do the satisfied users spend more time on making decisions or the unsatisfied users spend less time? Is user satisfaction a true substitute of objective measures for evaluating DSS success? What is the relationship between these two types of measures? Are they correlated? Is user satisfaction a redundant measure in evaluating system success?

The Research Model and Hypotheses

Figure 1 shows a simplified model of the relationships between user satisfaction, system effectiveness, and system success. An IS succeeds only when the intended users use it as expected and it is effective in achieving the intended system-specific objectives. If either of the two components is absent, the system cannot succeed. System success can be measured, depending on the research interest, in terms of the impact of the system on individual users, team, organization, industry, economy, or society. System use depends on system availability and users' attitude toward using the system reflected in user satisfaction. System use can be measured in terms of actual use (use behavior in the past) and intention to use (expected use behavior in the future). User satisfaction can be measured in terms of various dimensions articulated in the figure. System effectiveness depends on the quality of the system and of the information provided by the system. It can be measured in terms of achieving the system-specific objectives, such as improvements in decision quality, increased user learning, reduction in the time to make similar decisions, or increased system reliability. User satisfaction is often substituted for system effectiveness. However, a gap exists in research literature regarding the conceptual and empirical relationship between user satisfaction and system effectiveness (Goodhue et al. 2000; Melone 1990).

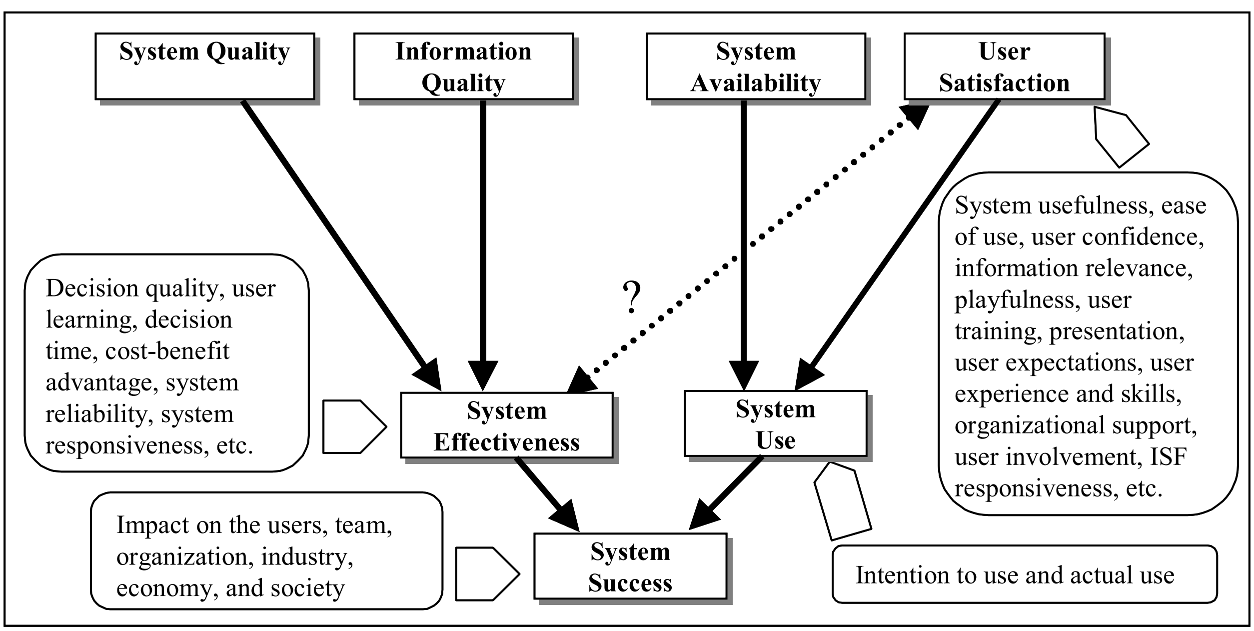

Figure 1: User Satisfaction, System Effectiveness, and System Success

The theories of reasoned action, fulfillment, discrepancy, attribution, expectation, disconfirmation, and performance effects are among the foremost theories discussing the determinants of user satisfaction (Barki 1990; Cyert and March 1963; Davis et al. 1989; Hufnagel 1990; Pearson 1977; Woodroof and Kasper 1995). According to the theory of reasoned action, the attitude toward a behavior stems from the belief and evaluation of behavioral consequences (Fishbein and Ajzen 1975). Thus, if the user perceives a system to be useful and easy to use, the user will be satisfied with the system and use it (Davis et al. 1989). According to the fulfillment theory, user satisfaction is determined by how much of a desired attribute one receives to fulfill one's needs (Cyert and March 1963; Pearson 1977). In decision-making, the desired attributes are the effective decision and efficient decision-making process measured by objective measures. According to the discrepancy theory, user satisfaction is based on user's perception of the difference between pre-established standards and actual performance (Woodroof and Kasper 1995). According to the attribution theory, the success is attributed to one's own ability (internal attributions) and effort, while failure is attributed to other's effort (external attributions) (Barki 1990; Hufnagel 1990). So, if the decision-making effectiveness is low, for whatever the reason, user satisfaction with the system is low. According to the expectation theory, user satisfaction is affected by prior expectations of users about the system and its effectiveness (Barki 1990). According to the disconfirmation theory, users have a tendency to disproportionately rate the difference between actual performance and expected performance (Barki 1990). So, user satisfaction can be affected by under or over estimation of system effectiveness. According to the performance theory, the level at which a system performs its function(s) influences user satisfaction (Barki 1990). All these theories, in some part, indicate a causal relationship between objective measures related to system effectiveness and user satisfaction, a subjective measure.

Perhaps due to this perceived causal relationship, some IS researchers have assumed substitutability and used one or the other measure. Some prefer subjective measures to objective measures, because the measurement of objective measures, especially in field studies, is problematic for multiple reasons. Most organizational IS are not designed to continuously monitor performance and user actions, so the accurate measurement of objective measures is very difficult. Without a behind-the-scene monitoring mechanism, the experimenter has to directly observe user activities, system usage, and system performance. This may intrude the privacy of users and create socially desirable behaviors by the users (Melone 1990). When a monitoring mechanism is used, it can have negative effect on system performance, especially efficiency. Another argument is that the restrictions imposed by the subjects or by the subject organizations enable only *ex-post* examination (Melone 1990). Objective measures, in some cases, may not be able to capture *ex-post*, delayed effects (Raymond 1987).

On the other hand, some IS researchers have disputed the use of subjective measures. Perceptual measures are retrospective and depend on the ability of individuals to accurately remember and interpret system effectiveness and usage behavior, whereas objective measures are concurrent (Melone 1990). Subjective measures reflect individuals' perception of performance outcomes rather than an objective assessment of system (Hufnagel 1990). Perceptual measures are also affected by prior belief, overblown expectations, and social desirability (Gelderman 1998). Subjective measures involve an intrusion and are often too cumbersome to be justified financially and practically (Downing 1999).

A reason for this debate is that the past studies did not empirically examine the relationship between objective and subjective measures, especially under controlled conditions (Gatian 1994; Gelderman 1998; Goodhue et al. 2000; Hubona and Cheney 1994). Figure 2 shows the research model we used to empirically evaluating this relationship in the context of decisional guidance. It uses three commonly used measures of DSS effectiveness, decision quality, user learning, and decision time. It uses six measurement dimensions of user satisfaction. Users' perceptions about DSS benefits, specifically information and decision support provided by the DSS, are represented by the relevance, confidence, and usefulness dimensions. Users' perceptions about DSS usability are represented by the ease of use, format, and playfulness dimensions. We have excluded the dimensions related to the services of information systems function (ISF), such as user training, documentation, user involvement, ISF responsiveness, support, and charge-back methods, as they are not relevant in this study. We have also excluded the dimensions related to personal traits of individual users, such as user expectations, user background, and user skills, because the research focus is not on evaluating the antecedents of user satisfaction.

Relevance represents the user's perception of how well guidance matches with the decision problem. Confidence represents the user's level of confidence in the reliability and dependability of guidance. Usefulness represents the user's perception of the system's usefulness as a decision aid and learning tool. Ease of use represents the user's perception of the system's user friendliness and smoothness in navigation. Format represents the user's satisfaction with the way in which guidance is presented. Playfulness represents the user's perception of the system's ability to motivate user and make the experience fun.

The following three hypotheses are developed to examine the relationship between user satisfaction and system effectiveness in two cases of a DSS with decisional guidance and a DSS without decisional guidance.

H1: *There is no relationship between decision quality and user satisfaction in a DSS with decisional guidance.*
H2: *There is no relationship between user learning and user satisfaction in a DSS with decisional guidance.*
H3: *There is no relationship between decision time and user satisfaction in a DSS with decisional guidance.*

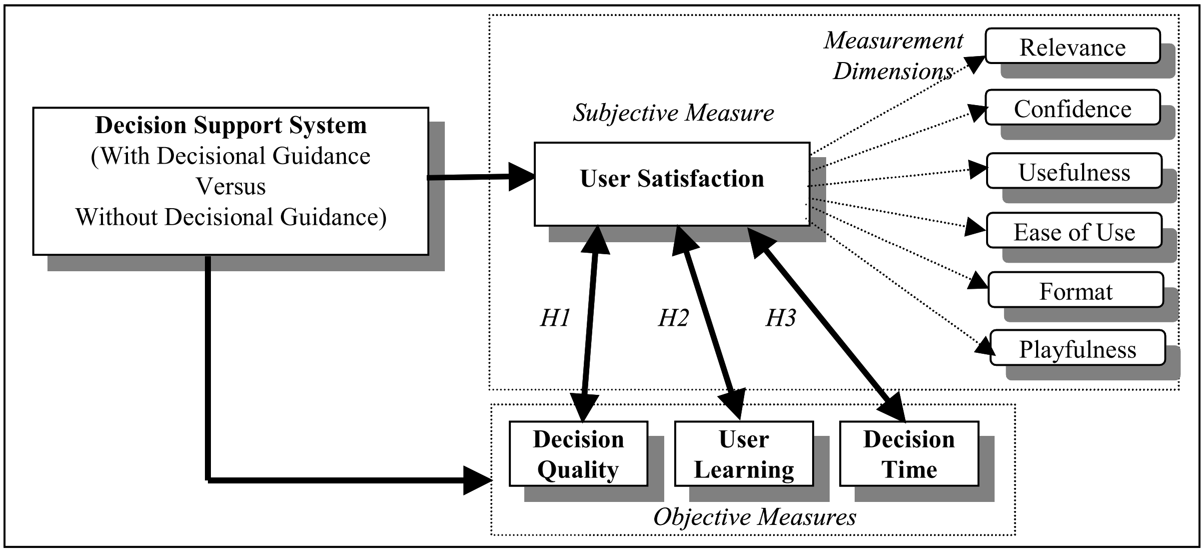

Figure 2. The Research Model: Decisional Guidance and Satisfaction

Research Methodology

We employed a laboratory experiment in a single factor completely randomized research design to test the hypotheses. This research design facilitated more accurate measurement of the effects of decisional guidance and better control over the effects of extraneous variables. In the experiment, each participant had to analyze four historical dataset and select the most appropriate forecasting model for each dataset. They use the assigned DSS in this process. This repeated treatments in four independent observations enabled us to reduce the *transient* and *chance* effects.

One hundred and forty-one sophomores and juniors from the BBA program of a large, urban US university voluntarily participated in this study. They were selected from a core course, which focused on forecasting models and using spreadsheet software to build and use these models. Because of their basic theoretical understanding of forecasting models, these participants were specifically suited to perform the decision task, which required informed decisions involving some degree of complexity and uncertainty in selecting the appropriate forecasting model. The participants were randomly assigned to one of the two groups—decisional guidance (DG) group using a DSS with decisional guidance and no-decisional guidance (NDG) group using a DSS without decisional guidance. The DG group was subdivided into four subgroups based on four types of decisional guidance derived from different combinations of *forms* and *modes* of decisional guidance suggested by Silver (1991). Both types of DSS had identical user interface, which presented the historical datasets, information about alternate solutions, and decision support in the same format. No user training was required because all DSS were simple to use. The systems automatically collected the study data by recording and time-stamping each user activity in a log file. An analysis of demographic characteristics suggests that all groups were statistically identical in age, gender, computer skills, and forecasting knowledge distributions (Contact the authors for additional details).

Measurement of Variables

For all hypotheses, the dependent variable is user satisfaction or a dimension of user satisfaction. Several instruments to measure user satisfaction have been developed or adapted to meet the needs of specific studies (Benard and Satir 1993; Doll and Torkzadeh 1988; Etezadi-Amoli and Farhoomand 1996; Ives et al. 1983; Kettinger and Lee 1994; Pearson 1977; Sanders and Courtney 1985; Sengupta and Zviran 1997). There is no universally accepted instrument to measure user satisfaction. For this study, we developed, based on a comprehensive review of previously-used instruments, a questionnaire consisting of one global question measuring overall user satisfaction and 17 additional questions measuring user satisfaction on the six dimensions (contact the authors to get a copy of the questionnaire). Several tests, such as Cronbach Alpha, correlation analysis, and Varimax factor analysis, were conducted on the instrument. These tests found the instrument to be reliable (Alphas more than .7), internally consistent, and valid (factor loadings more than .5)

For the hypothesis H1, the predictor variable is decision quality. Decision quality was measured in terms of the deviation of the participant's selection of most appropriate forecasting model from the experts' selection for each historical dataset. For the hypothesis H2, the predictor variable is user learning. User learning about the problem domain is the difference between what a user knew immediately before the treatment and what the user knew immediately after the treatment. In the experiment, each participant took a pre-test before and an identical post-test after performing four decision tasks. These tests measured the forecasting knowledge of the participant at the given time. The differences in the test scores are used in the analyses. For the hypothesis H3, the predictor variable is decision time. Decision time was measured as the total time minus the time spent in the guidance. (Contact the authors for additional details).

Results and Discussion

To test each of the three hypotheses, we performed two regression analyses—one on the global satisfaction question and the other on the factor scores (obtained from the construct validity analysis) of the six dimensions—and six individual T-tests on the six dimensions for the DG group. Similar analyses were also performed separately for the NDG group to provide a comparison. The two groups were separated in the analyses to block out the effects of decisional guidance. The results of all analyses and tests are summarized in Table 1, 2, and 3. As a caveat, the findings of the analyses pertaining to the NDG group may be inconclusive because of the small participant size (24 participants, though total 96 observations).

The results shown in Table 1 indicate that F values are higher than critical F values for the DG group in the two regression analyses suggesting that there is a statistically significant relationship between decision quality and user satisfaction as an overall construct. However, the adjusted R^2s are very low (7.1% on the global question and 15.9% on the six dimension) indicating the weakness of the relationship. For the NDG group, the F values are lower than critical F values confirming no relationship. Individual T-tests on the DG group show that only the confidence and usefulness dimensions of user satisfaction have significant relationships (p<.01) with decision quality. While other dimensions (relevance, ease of use, format, and playfulness) did not have significant relationship. Similar tests on the NDG group show no significant relationships on all six dimensions.

Table 1. Decision Quality and User Satisfaction

		Decisional Guidance		No Decisional Guidance	
Overall User Satisfaction	Adjusted R Square	.071		.110	
	F (P)	9.930 (.002)		3.847 (.063)	
Individual Dimensions	Adjusted R Square	.159		.246	
	F (P)	4.661 (<.000)		2.252 (.088)	
	Dimensions	**T**	**P**	**T**	**P**
	Relevance	2.354	.020	-1.566	.136
	Confidence	3.001	.003	-.934	.363
	Usefulness	2.661	.009	2.737	.014
	Ease of Use	.520	.604	.881	.391
	Format	2.518	.013	.617	.545
	Playfulness	1.782	.077	1.216	.241

Decision quality is a measure of the appropriateness of the decision. In most business decision-making situations, decision quality is not known until after the decision is implemented and its impact is known, which may take months or years. Therefore, a decision-maker does not always know decision quality immediately after the decision is made for it to affect the decision-maker's satisfaction with the DSS. Additionally, decision quality can be sometime very difficult to measure because the impact is a result of a series of sequential decisions rather than just the decision under study or of the poor implementation of the decision. Thus, the decision-maker cannot directly attribute decision quality with the DSS used in making the decision. The research design simulated these conditions in the laboratory experiment leading to the results indicating decision quality has a very weak effect on user satisfaction.

Table 2. User Learning and User Satisfaction

		Decisional Guidance		No Decisional Guidance	
Overall User Satisfaction	Adjusted R Square	-.008		-.02	
	F (P)	.114(.736)		.560 (.462)	
Individual Dimensions	Adjusted R Square	.053		.017	
	F (P)	2.083 (.061)		1.066 (.420)	
	Dimensions	**T**	**P**	**T**	**P**
	Relevance	.957	.341	2.145	.047
	Confidence	-1.071	.287	.336	.741
	Usefulness	-.384	.702	-.752	.462
	Ease of Use	-1.533	.128	.902	.380
	Format	2.252	.026	-.078	.939
	Playfulness	1.540	.126	.625	.540

The results shown in Table 2 indicate that F values are less than critical F values for both regression analyses for both groups suggesting there is no significant relationship between user satisfaction and user learning. Additionally, the adjusted R^2s are extremely low supporting the non-existence of the relationship. Individual T-tests on the six dimensions also show that none of the dimensions has a significant relationship with learning.

Learning is an indirect benefit of using DSS in decision-making. While using a DSS, the user learns about the DSS, the problem domain, and the process of decision-making. A part of this learning happens unconsciously without the user making explicit efforts or intending to learn. Additionally, decision support and decision guidance are not provided in the form of study tutorials, so the user may not even perceive the learning effects even though they are real. This has probably led to user learning having no direct effect on user satisfaction.

Table 3. Decision Time and User Satisfaction

		Decisional Guide		No Decisional Guide	
Overall User Satisfaction	Adjusted R Square	-.009		.115	
	F (P)	.013(.909)		3.985 (.058)	
Individual Dimensions	Adjusted R Square	-.01		.056	
	F (P)	.813 (.562)		1.229 (.340)	
	Dimensions	**T**	**P**	**T**	**P**
	Relevance	-.579	.564	.290	.775
	Confidence	-.251	.802	-.621	.543
	Usefulness	1.459	.147	1.824	.086
	Ease of Use	-1.345	.181	1.531	.144
	Format	-.060	.952	.929	.366
	Playfulness	-.174	.863	.510	.617

The results shown in Table 3 indicate that F values are less than critical F values for both regression analyses for both groups suggesting no significant relationship between user satisfaction and decision time. Additionally, the adjusted R^2s are extremely low supporting the non-existence of the relationship. Individual T-tests on the six dimensions also show that none of the dimensions has a significant relationship with decision time.

Decision time refers to the time spent by the user in making the decision. Decision support and decisional guidance increase the ability of the user to find and evaluate more alternatives. This may lead to higher satisfaction and higher decision time. On the other hand, decision support and decisional guidance also improve the user's ability to quickly evaluate and reject inappropriate alternatives. This may lead to higher satisfaction but lower decision time. The results indicate that these two opposing forces may have balanced each other creating a zero resultant effect.

Barki (1990), Gatian (1994), Etezadi-Amoli and Farhoomand (1996), and Gelderman (1998) found user satisfaction to be correlated to effectiveness (system performance). However, their studies were different from this study in many aspects: they measured user's perceptions of performance rather than actual performance; they were field studies and not controlled laboratory experiments; they evaluated IS and not DSS; they focused on all IT applications rather than one specific aspect of IT use; and the performance measures they used were also different from each other and this study. This study results are consistent with their findings only in a very limited way. Actual performance in terms of decision quality is correlated to some of the dimensions of user satisfaction (confidence and usefulness) but not all. However, when performance is viewed in terms of user learning and decision time, this study does not confirm those studies. Hufnagel (1990) found in a laboratory experiment involving a support system (just a calculator) that users who were successful in performing the decision task (better decision quality) attributed their performance to their own efforts and understanding, while the users who were unsuccessful (lower decision quality) blamed luck and the quality of the system. Thus, she found no correlation between user satisfaction and decision quality in the absence of a DSS. This study confirms her findings for a DSS without decisional guidance. Davis and Kottemann (1994) found in an experiment involving a DSS with "what-if" analysis, that users perceived the DSS to be more beneficial than no DSS, though there was no significant difference in performance (in terms of decision quality) between the two groups. They compared actual performance with perceived performance. This study confirms that actual performance is not correlated to user satisfaction when decisional guidance is not present in a DSS. However, when decisional guidance was present, user satisfaction was correlated to decision quality contradicting previous findings. This could be because decisional guidance enlightened the users as they structured and executed decision-making process and the users were able to assess the improvement in decision quality attributable to decisional guidance (Silver 1991).

Conclusion

Researchers have often substituted user satisfaction with objective measures and vice versa to examine the effectiveness and success of various IS and IT applications without explicitly testing the relationships between the measures (Gatian 1994; Gelderman 1998; Goodhue et al. 2000; Hubona and Cheney 1994; Melone 1990). This study found a very weak relationship between three objective measures and user satisfaction in the case of DSS. The results confirm that user satisfaction is not a true substitute of the objective measures of system effectiveness. This also reinforces Melone's (1990) argument that system effectiveness may not be related to user satisfaction. It is possible to have an "effective" system with unsatisfied users and an "ineffective" system with satisfied users. Thus, measuring and improving both user satisfaction and system effectiveness is critical for system success. Objective measures provide formal evaluation whereas subjective measures provide informal evaluation, which is helpful and necessary to confirm the results of the formal evaluation (Hamilton and Chervany 1981). Many researchers suggest that user satisfaction is one of multiple measures of IS success. Keen and Scott Morton (1978) recommended using a "smorgasbord" approach utilizing both subjective and objective measures for evaluating a DSS. Doll and Torkzadeh suggested (1988, p.272): "End-user satisfaction is only one of several relevant measures of end-user computing success." DeLone and McLean (1992) distinctly identified user satisfaction as one of the six measures of IS success along with system quality, information quality, use, individual impact, and organizational impact. Overlooking either type of measures leads to inconclusive and potentially misleading evaluation.

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