MEASURING EFFECTIVENESS OF COMPUTING FACILITIES IN ACADEMIC INSTITUTES A NEW SOLUTION FOR A DIFFICULT PROBLEM

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Abstract: There has been a constant effort to evaluate the success of Information Technology in organizations. This kind of investment is extremely hard to evaluate because of difficulty in identifying tangible benefits, as well as high uncertainty about achieving the expected value. Though a lot of research has taken place in this direction, but not much is written about evaluating IT in non-profit organizations like educational institutions. Measures for evaluating success of IT in such kind of institutes are markedly different from that of business organizations. The purpose of this paper is to build further upon the existing body of research by proposing a new model for measuring effectiveness of computing facilities in academic institutes. As a baseline, Delone & McLean's model for measuring the success of Information System (DeLone & McLean 1992,DeLone & McLean 2003) is used, as it is the most pioneering model in this regard.

1 INTRODUCTION

Given the crucial role of education in development and the expansion of Information and Communication technology in the global economy, the role of IT in education cannot be ignored. Of late there has been a major surge in the use of IT in the territory of education. This, at the same time, has raised the questions- How effective is IT in academic institutions? How to measure the effectiveness/ success of IT in educational institutions? Effectiveness is concerned about the impact of the information provided in helping users do their job. It is important to evaluate the impact of the IT on the organization as a whole rather than looking at the quality of the system, user satisfaction or by looking at a narrow financial perspective of the evaluation.

The difficulties in effectively evaluating the impact of information systems are widely acknowledged in the IS literature (DeLone et al 1992, Willcocks & Lester 1996, Willcocks 1996).

Evidence suggests that poor performance of the IS function is a serious inhibitor to good business performance (Carlson & McNurlin 1992b). Better use of information, both internal and external, relates positively to profitability (Strassman 1990).

A lot of research has been undertaken in this regard to develop frameworks for measurement of Information Systems' success. Economic and quantitative measures for the success of IS, however, are difficult to obtain. Researchers and practitioners alike often rely on subjective assessment and surrogate measures, such as end-user computing satisfaction (EUCS) instrument.

Saunders and Jones (1992) developed the "IS Function Performance Evaluation Model" which was used to describe how measures should be selected from the multiple dimensions of the IS function relative to specific organizational factors and based on the perspective of the evaluator.

The model proposed by Delone et al (1992,2003) to measure the effectiveness of Information System is the most pioneering work in this regard. DeLone and McLean Information Systems (IS) Success

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Model is a framework and model for measuring the complex-dependent variable in IS research. It concludes with a model of "temporal and causal" interdependencies between their six categories of IS success- *Information Quality*, *System Quality*, *Use*, *User Satisfaction*, *Individual Impact*, and *Organizational Impact*.

Their model depicts the relationships of the 6 IS success dimensions. They contend that System Quality and Information Quality singularly and jointly affect both Use and User Satisfaction. Additionally, the amount of Use can affect the degree of User satisfaction. Use and User Satisfaction are direct antecedents of Individual Impact; and lastly, this impact on individual performance should eventually have some Organizational Impact. This model was later on validated by many researchers including Seddon and Kiew (1994), who tested the causal structure of the model.

Inspite of being the most complete and a better known model some shortcomings have been sighted in this model by researchers. It does not take into consideration the effect of extraneous variables both internal and external to the organization. They themselves accept that it is necessary to include the organization type and its environment into context before applying this model.

In the light of the above argument, we have made an attempt to modify Delone and McLean's model to make it relevant for measuring the effectiveness of computing facilities in academic institutes. Information Quality and System Quality have been replaced by Usability and Functional Utility. Use construct is omitted from the proposed model. Measures for evaluating success of IT in such kind of institutes are markedly different from that of business organizations. Therefore, for capturing Individual Impact and Organizational Impact measures suitable in the context of academic institutes have been introduced.

2 PROPOSED MODEL

Following modifications have been proposed in the Delone & McLean's model

Replacing System Quality and Information Quality:

We are concerned with measuring effectiveness of all the computing facilities of an academic institute unlike (DeLone et al 1992) where focus is on an individual Information System. Therefore, System Quality and Information Quality have been replaced by Usability and Functional Utility.

Omission of Use construct:

A main criticism of Delone and McLean has centered on the *Use* construct. It is considered to be an inappropriate measure of IS success. Its implication is that if a system is used, it must be useful, and therefore successful. Take the example of an expensive design software, which is used only by handful of students. If this software helps these students to produce some excellent research work, it will be considered as an asset for the institute, irrespective of the number of students using it. Hence, Use construct was considered as inappropriate in this context.

Taking the points mentioned above into consideration, the proposed model includes the following five constructs- Usability, Functional Utility, User Satisfaction, Individual Impact and Organizational Impact. The relationship between the constructs is as shown in Fig. 1.

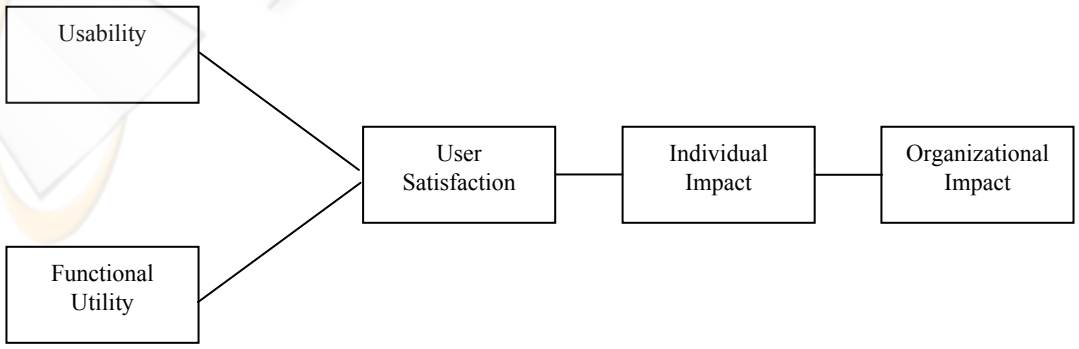

Figure 1: Proposed model.

This model shows the interdependent nature of success categories used.

Usability measures the extent to which the computing facilities match user characteristics and the skills for the tasks concerned. Functional Utility focuses on how well the computing facilities meet the requirements of the users. It also measures the availability, accuracy and up-to–datedness of the information obtained from the use of computing facilities. User satisfaction is the most extensively used single measure for IS evaluation (Delone et al 1992). End-user's feelings of satisfaction arise when he or she combines his or her perception of and valuation of discrepancy regarding desires and expectations from the use of computing facilities. Individual Impact and Organizational Impact indicate the impact of computing facilities on individual performance and organizational performance, respectively. Measures used for Individual Impact are concerned with evaluating the impact of computing facilities on an individual in learning, course work, research work, planning and decision making, communication and overall productivity. Likewise, Measures of Organizational Impact evaluate the impact of comporting facilities on the organizational as a whole in the following respects- innovation, research quality, pass rate/grades, decision making, image of the institute, capacity in terms of students, and overall productivity of the institute.

3 MODEL VALIDATION

Aim of testing this model was to provide an empirical evidence for the relationships between the five constructs used in the proposed model. We conducted a self-administered survey to collect the primary data from the target population, which consisted of students and faculty of five academic institutes.

For the survey, a questionnaire was designed based on discussions with students and faculty and literature. Respondents were asked to fill the questionnaire in the context of computing facilities used in their institutes.

Questionnaire contained five sets of questions to measure the five constructs of the model.

Questions were framed by discussions with students and faculty of various academic institutes and available literature. To evaluate the first construct Usability, a set of four questions was used. For measuring Functional Utility six questions were framed. Four questions on Overall Satisfaction were from Seddon and Yip (1992). To measure Individual Impact and Organizational Usability measures the extent to which the computing facilities match user characteristics and Impact group of five and six questions were used, respectively.

Likert scale was used for measurement in which respondents indicate a degree of agreement or disagreement with each of a series of statements about the stimulus objects. Each statement has been assigned seven response categories, ranging from 1 to 7. One signifies strong agreement, and seven means strong disagreement.

3.1 Data Collection

Questionnaires were administered personally to the students and faculty of the aforementioned institutes. Total of 500 Questionnaires were distributed, out of which, 411 completed questionnaires were returned by the respondents. After screening of questionnaires to identify illegible, incomplete, or ambiguous responses, 31 questionnaires were rejected. Total, 380 questionnaires were found suitable for data analysis. Treatment of missing values was done by substituting a neutral value.

3.2 Data Analysis and Results

To establish the model, three regression models have been used

- Multiple regression model with Usability and Functional Utility as independent variables and User Satisfaction as dependent variable.
- Simple regression model with User Satisfaction as independent variable and Individual Impact as dependent variable.
- Simple regression model with Individual Impact as independent variable and Organizational Impact as dependent variable.

Using the abbreviations

X_1 = Usability
X_2 = Functional Utility
X_3 = User Satisfaction
X_4 = Individual Impact
X_5 = Organizational Impact

the following linear regressions are considered

$$X_3 = b_{3.12} + b_{31.2} X_1 + b_{32.1} X_2 \quad (1)$$

$X_4 = b_{4.3} + b_{43} X_3$ (2)

$X_5 = b_{5.4} + b_{54} X_4$ (3)

The eq. (1) represents a multiple linear regression and (2) and (3) are simple linear regressions, hereafter called Simple Regression 1 and Simple Regression 2 respectively.

Here $b_{3.12}$, $b_{4.3}$ and $b_{5.4}$ are constants; b_{43} and b_{54} are regression coefficients ,$b_{31..2}$ and $b_{32.1}$ are partial regression coefficients. The suffix after the dot refers to the variable held constant.

3.3 Hypotheses

The hypotheses to be tested are as follows:

H1: The partial regression coefficient $b_{31..2} > 0$
It is assumed that if the user finds the computing facilities easy to use, perceived usefulness of the system will increase for him. This subsequently, will result into increased User Satisfaction.
H2: The partial regression coefficient $b_{32..1} > 0$
Increase in Functional Utility will result into increased usefulness for the user and hence increased satisfaction. The more the facilities meet the requirements of the user the more will be the User Satisfaction
H3: The regression coefficient $b_{43} > 0$
This hypothesis states that if a student is more satisfied with the computing facilities then it will have a more positive Individual Impact e.g. better learning or communication with students/faculty.
H4: The regression coefficient $b_{54} > 0$
Higher Individual Impact will result into higher Organizational Impact e.g. a positive effect of computing facilities on learning of individual students will result into overall improvement in pass rate/ grades of the institute.

Data analysis was done using SPSS.

Table 1: Cronbach's alpha.

	No. of Items	Cronbach alpha
Usability(X_1)	4	.6790
Functional Utility(X_2)	6	.8479
User Satisfaction(X_3)	4	.8497
Individual Impact(X_4)	6	.8772
Organizational Impact(X_5)	7	.8796

High Cronbach's alpha for all the variables in Table 1, except for Usability, which is marginally less, is an indication of high internal consistency. Low value for Usability can be attributed to lower number of items used to measure it.

Table 2: Pearson Correlation matrix.

	X_1	X_2	X_3	X_4	X_5
Usability(X_1)	1				
Functional Utility(X_2)	.562	1			
User Satisfaction(X_3)	.602	.815	1		
Individual Impact(X_4)	.551	.774	.817	1	
Organizational Impact(X_5)	.537	.722	.769	.812	1

Table 2 shows the Pearson Coefficient of Correlation between all the variables. Pearson's correlation coefficient (r) is a measure of the strength of the association between the two variables.

The coefficient of correlation between the constructs Usability and Functional Utility is low, which indicates their independence. The coefficients of correlation are high for the constructs Functional Utility and User Satisfaction; User Satisfaction and Individual Impact; Individual Impact and Organizational Impact as suggested by the model. However, it is on the lower side for the constructs Usability and User Satisfaction, which suggests that dependence of User Satisfaction is higher on Functional Utility as compared to Usability.

Table 3.

	R^2	Adjusted R^2	F (p-value)
Multiple Regression	.695	.693	428.747 (0)
Simple Regression 1	.667	.666	757.880 (0)
Simple Regression 2	.659	.658	729.581 (0)

The high values of t and F- statistic in all the cases strongly support the rejection of the Null hypotheses, that the regression coefficients are zero. The regression coefficients except for $b_{31.2}$ have high positive values. Also the 95% confidence intervals are small. The coefficients of determination show reasonably good fit. All the above results tend to validate the model and support all the four hypotheses.

4 CONCLUSIONS

Results obtained from path analysis of the survey data provide considerable empirical evidence for the model. Results show strong dependence of User Satisfaction on Usability and Functional Utility; Individual Impact on User Satisfaction and Organizational Impact on Individual Impact. All the four Hypotheses assumed in the beginning of the research are found be true.

An implication of the model is that because of the causal nature of these dimensions, Usability, Functional Utility and User Satisfaction are sufficient to measure the effectiveness of computing facilities.

On the basis of the small piece of work done in this thesis, it is strongly recommended that every academic institution should undergo through this self screening or self assessment process. This model can be used by academic institutes to get regular feedbacks about their computing facilities, which will help them in continuous improvements.

An attempt has been made to include all the suitable measures of each construct. However, there is a scope of including new measures for each of the constructs. More questions can be added to the questionnaire to measure each of these constructs, including both positive and negative statements to check the consistency of the respondents. Finally, inclusion of other constructs in the model can be investigated.

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Table 4.

	Path		Unstandardized Coeff.		Std. Coeff.	t (p-value)	95% Conf. Bounds	
	from	to	Coeff	Std. Er.			Lower	Upper
H1	Usability	User Satisfaction	.228	.037	.211	6.126 (0)	.155	.302
H2	Functional Utility	User Satisfaction	.737	.036	.696	20.234 (0)	.666	.809
H3	User Satisfaction	Individual Impact	.779	.028	.817	27.530 (0)	.723	.835
H4	Individual Impact	Organizational Impact	.798	.030	.812	27.011 (0)	.740	.856

APPENDIX: SURVEY ON COMPUTING FACILITIES IN ACADEMIC INSTITUTES

This questionnaire uses a seven-point scale. The scale represents a spectrum. 1 signifies that you strongly agree with the given statement, and 7 means you strongly disagree. For each question tick the number that reflects what you think about each statement. Computing facilities refer to computer hardware, software and network of your institute.

PART A: Usability

1 Computing facilities are easy to use.	1 2 3 4 5 6 7
2 Computing facilities are user friendly.	1 2 3 4 5 6 7
3 It is easy to acquire skills for using the Computing facilities.	1 2 3 4 5 6 7
4 It requires lot of effort to use the Computing facilities	1 2 3 4 5 6 7

PART B: Functional Utility

1 Computing facilities meet most of your requirements.	1 2 3 4 5 6 7
2 The content of information obtained with the help of computing facilities meets your requirements.	1 2 3 4 5 6 7
3 Computing facilities are available whenever required.	1 2 3 4 5 6 7
4 You can get in touch with sufficient sources of information by using computing facilities.	1 2 3 4 5 6 7
5 Computing facilities enable you to obtain accurate information.	1 2 3 4 5 6 7
6 Computing facilities enable you to obtain up-to-date information.	1 2 3 4 5 6 7

PART C: User Satisfaction

1 Computing facilities meet your information processing and computational needs.	1 2 3 4 5 6 7
2 Computing facilities are fast enough.	1 2 3 4 5 6 7
3 Computational facilities are effective.	1 2 3 4 5 6 7
4 Overall,you are satisfied with the computing facilities.	1 2 3 4 5 6 7

PART D: Individual Impact

1 Computing facilities help you in learning.	1 2 3 4 5 6 7
2 Computing facilities help you in course work.	1 2 3 4 5 6 7
3 Computing facilities help you in research work.	1 2 3 4 5 6 7
4 Computing facilities help you in planning and decision making.	1 2 3 4 5 6 7
5 Computing facilities help you in communication with teachers and students.	1 2 3 4 5 6 7
6 Computing facilities help you in improving your overall productivity.	1 2 3 4 5 6 7

PART E: Organizational Impact

1 Computing facilities help in encouraging innovation.	1 2 3 4 5 6 7
2 Computing facilities help in improving research quality.	1 2 3 4 5 6 7
3 Computing facilities help in improving overall pass rate/grades.	1 2 3 4 5 6 7
4 Computing facilities help in better decision making.	1 2 3 4 5 6 7
5 Computing facilities help in improving the image of the institute.	1 2 3 4 5 6 7
6 Computing facilities help you in increasing capacity in terms of students.	1 2 3 4 5 6 7
7 Computing facilities help in improving overall productivity of the institute.	1 2 3 4 5 6 7