Assessment of End-User Computing from an Organizational Perspective

FRANÇOIS BERGERON
Université Laval

SUZANNE RIVARD
Ecole des Hautes Etudes Commerciales

LOUIS RAYMOND
Université du Québec à Trois-Rivières

While the end-user computing (EUC) phenomenon has been investigated by several researchers, few efforts have been made up to now to rigorously define the dependent construct that should be used in this research, namely EUC success. This paper presents the results of an empirical study designed to determine the actual importance, from an organizational perspective, of 30 EUC success criteria identified in the literature. An attempt was also made to verify whether this importance changes as end-user computing evolves in organizations. Results indicate the presence of five components underlying the success criteria. In order of decreasing importance for organizations, EUC success criteria pertain to organizational effectiveness, user appreciation, quality, efficiency and adequacy of EUC applications. This order remains the same whatever the level of EUC growth attained. However, the emphasis placed on effectiveness, quality and efficiency increases as end-user computing matures within organizations.

End-user computing (EUC) will likely have been to the 80s what the implementation of computers in organizations was to the 70s: a tremendous change in the way organizations work. Not only was the change an important one, it also took place at an extremely rapid rate. While in the early 80s, firms barely devoted any resources to supporting EUC activities (Benjamin, 1982), it was recently reported that organizations now allocate, on the average, 40% of their information systems (IS) budget to support such activities (Evans, 1989). Because of the newness of the phenomenon, its rapid diffusion and its complexity, mainly due to the large number of players and the large amounts of money involved, successful management of end-user computing becomes a true organizational challenge.

An end-user is an organizational member outside the information systems department who makes direct use of a computer (micro, mini, or mainframe) to accomplish a variety of tasks such as report generation, data analysis, word processing and electronic mail (Rivard and Huff, 1988). Several researchers and practitioners alike have studied the end-user computing phenomenon. Their studies, models and propositions have taught us much about end-user computing and its context, as well as about some aspects of its management. However, up to now, few efforts have been made to rigorously define the dependent variable that should be used in EUC research, that is, to define success.

While different measures of success are proposed and used in the literature, few attempts were made to determine whether organizations perceive these measures as being both relevant and important. Moreover, authors appear to assume that the particular success measure they use is appropriate to all circumstances,

Manuscript originally submitted October 23, 1991; Revised April 2, 1992; Accepted May 18, 1992 for publication.

regardless of any contingencies. Since a number of researchers have suggested that end-user computing evolves in organizations following a pattern that resembles a learning curve (Rockart and Flannery, 1981; Henderson and Treacy, 1986; Alavi, Nelson and Weiss, 1987; Magal, Carr and Watson, 1988; Huff, Munro and Martin, 1988, Magal, 1989), the question of whether the importance of success criteria varies with this evolution appears relevant.

The objective of the study reported here was to answer, albeit partially, the two questions raised previously. The first pertains to the identification of the most important success criteria for EUC, while the second addresses the changes in the importance of the criteria as EUC evolves in organizations. The following paragraphs briefly review the EUC literature, first, in an attempt to identify the various success criteria suggested, and second, in order to circumscribe the concept of end-user computing evolution. The methodology used to conduct the study is then outlined, followed by a presentation and a discussion of the results.

End-User Computing Success

Few of the earlier studies on end-user computing have provided an explicit definition of success for the phenomenon. Rather, they attempted to describe it by proposing end-user taxonomies, suggesting typologies for classifying end-user computing activities, describing the technological and support environments that were provided to users, and identifying the major management and research issues (McLean, 1979; Rockart and Flannery, 1983; Benson, 1983; Alavi, 1985; Rivard and Huff, 1985; Sumner, 1985; Wetherbe and Leitheiser, 1985; Alavi and Weiss, 1986; Raymond, 1987). Nevertheless, a careful examination of this literature reveals a number of success criteria. For instance, some authors suggested that application development by end-users could potentially lead to systems that better respond to user needs, at lower costs (McLean, 1979; Rivard and Huff, 1985). Others claimed that end-user computing could improve user productivity (Alavi, 1985a; Rivard and Huff, 1985; Porter, 1985), allow faster access to information (Guimaraes, 1984; Aberth, 1987), respond to user needs in a more timely fashion (Alavi, 1985b; Rivard and Huff, 1985; Aberth, 1987), increase user autonomy vis-a-vis the information systems department (Quillard and Rockart, 1984), and contribute to higher user satisfaction or to more efficient applications (Rivard and Huff, 1984).

Later on, as the phenomenon matured, researchers became interested in testing models of success for end-user computing. In order to do so, the dependent variable had to be formally defined. Interestingly enough, there exists, as in the earlier studies, a wide variety in these definitions of success. While a number of authors adopted user satisfaction as their dependent variable (Cheney, Mann and Amoroso, 1986; Alavi, Phillips and Freedman, 1986; Bergeron and Bérubé 1988; Rivard and Huff, 1988; Doll and Torkzadeh, 1989, Raymond and Bergeron, 1992), others used decision-making performance (Kasper, 1985; Kasper and Cerveny, 1985), self-determination and level of stress (Alavi et al., 1986, 1990), utilization of end-user computing (Ein-Dor and Segev, 1991), or application quality (Jarvenpaa and Machesky, 1987; Corman, 1988; Rivard, Lebrun and Talbot, 1991).

While this enumeration of success criteria is rather long, it is not exhaustive. The literature review performed for this study, resulted in the identification of 30 success criteria. They are outlined in Table 1, along with authors who suggested them. The success criteria are grouped into five factors for the purpose of presentation. The groupings result from a factor analysis made on data collected in this survey and on which details are presented later in this paper. Given the number and the variety of success criteria contained in the list, the researcher is faced with the dilemma of selecting the most appropriate definition of success for a given study. In order to facilitate this task, this study attempted to provide some elements of response to the following research question:

> *What are the most important success criteria for end-user computing from an organizational perspective?*

Evolution of End-User Computing

It is a premise shared by several IS researchers and practitioners that technology adoption evolves in organizations following a learning curve type of pattern (Nolan, 1979; McKenney and McFarlan, 1982). Although the empirical bases for such a view have been questioned (Benbasat et al., 1984), it has proven to be a useful diagnosis and planning tool, for researchers and practitioners alike (Mahmood and Becker, 1986). Several authors involved in end-user computing research have recognized the relevance of the learning curve hypothesis for describing and explaining the evolution of end-user computing in organizations; they also used

ORGANIZATIONAL EFFECTIVENESS

- Improvement in organizational effectiveness (Keen, 1983; Porter, 1985; Amoroso, 1986; Gerrity andRockart, 1986; Kosinar, 1987)
- Improvement in organizational performance (Keen and Woodman, 1984; Rivard and Huff, 1985; BrittainWhite, 1986; Aberth, 1987)
- Increase in the quality of decision-making (Kasper, 1985; Kasper and Cerveny, 1985; Brittain White,1986; Amoroso, 1988)
- Improvement in the decision-making quality (Brittain White, 1986; Amoroso, 1988)
- Attainment of organizational objectives (Amoroso, 1986; Cheney, Mann and Amoroso, 1986)

USER APPRECIATION

- Easier access to information (Quillard and Rockart, 1984; Aberth, 1987; Amoroso, 1988)
- Quicker access to information (Guimaraes, 1984; Aberth, 1987)
- Increase in the use of existing information systems (Painter, 1988; Guimaraes, 1984)
- Increase in data processing capacity (Painter, 1988; Guimaraes, 1984)
- Increase in the quality of information(Quillard et al., 1984)
- Better communication capacity (Quillard et al., 1984)
- User satisfaction (Cheney et al., 1986; Alavi, Phillips and Freedman, 1986; Bergeron and Bérubé, 1988;Doll and Torkzadeh, 1988, 1989; Rivard and Huff, 1988; Yaverbaum, 1988; Alavi et al., 1990; Raymond,1990; Amoroso and Cheney, 1991; Brown and Brancheau, 1992; Raymond and Bergeron, 1992)
- Efficient use of tools by the users (Fuerst and Martin, 1984; Gattiker and Paulson, 1987; Sein and Bostrom, 1987; Raymond et al., 1988; Rivard et al., 1991)

EFFICIENCY OF APPLICATIONS

- More work accomplishment by users (Alavi, 1985a; Porter, 1985; Rivard et al., 1985; Yaverbaum, 1988; Pentland, 1989; Brown et al., 1992)
- Low cost applications (Rivard and Huff, 1984, 1985; Kappelman et al., 1991)
- Reduction in users' work effort (Porter, 1985)
- Savings in the development of applications by users (Davis, 1982; Rivard et al., 1985)
- Time savings (Rivard et al., 1985; Aberth, 1987; Amoroso, 1988)
- Effective execution of tasks (Alavi, 1985b; Porter, 1985; Kosinar, 1987; Raymond et al., 1988)
- Cost-effectiveness of end-user computing as compared to other possibilities (Painter,1988; Guimaraes,1984)
- Cost-benefits of applications (Rivard et al., 1984; Amoroso, 1986)

QUALITY OF APPLICATIONS

- No duplication of applications (Painter, 1988; Guimaraes, 1984)
- No data redundancy (Keen, 1983; Corman, 1988)
- Error free applications (Davis, 1982; Beheshtian and Van Wert, 1987; Raymond et al., 1988; Rivard etal., 1991; Alavi et al., 1990)
- Quality of information (Davis, 1982; Quillard et al., 1984; Corman, 1988)
- Quality of user databases (Keen, 1983; Alavi and Weiss, 1985; Sumner and Klepper, 1987; Jarvenpaa and Machesky, 1987; Corman, 1988; Ra ymond et al., 1988; Klepper and Sumner, 1990)

ADEQUACY OF APPLICATIONS

- Information systems applied to major organizational problems (Huber, 1981; Henderson and Treacy,1986)
- User autonomy (Quillard et al., 1984; Rivard et al., 1985)
- Competitive advantage (Gerrity and Rockart, 1986; Henderson et al., 1986)
- Balance between local autonomy of applications and their integration to organizational systems (Keen,1983; Gerrity et al., 1986)

Table 1: Success Criteria for End-User Computing from the Literature

the learning curve model to stress the importance of applying the management strategies that are best suited to a given stage (Rockart and Flannery, 1981, 1983; Henderson and Treacy, 1986; Alavi et al., 1987; Magal et al., 1988; Huff et al., 1988; Raymond, 1990).

This contingency view of end-user computing management was not fully exploited by researchers in their studies of EUC success models. That is, almost all researchers assume that the variables in their models are appropriate, notwithstanding the stage of evolution of end-user computing in an organization. One exception exists though. Magal et al. (1988) stated the hypothesis that critical success factors for the management of an information center varied in importance along with the evolution of the information center. The present study differs from this previous one on three aspects. First, Magal et al.'s study pertained to information centers per se, rather than on end-user computing in general. Second, their study examined the independent variable, that is, determinants of success, while the present study focusses on the dependent variable, the success construct itself. Finally, Magal et al. used a categorization of the stages of evolution that was akin to that proposed by Nolan (1979) for describing the growth of traditional data processing in organizations. In the present research, a categorization developed for the express purpose of describing the evolution of end-user computing was adopted, namely, the one proposed by Huff, Munro and Martin (1988). In this model, the maturity of applications developed by end-users is adopted as the prime indicator of the stage of EUC growth. Five distinct stages are identified: isolation, stand-alone, manual integration, automated integration, and distributed integration.

From this line of thought, the second question to be addressed by this study was raised:

Does the importance of the various success criteria change as end-user computing evolves in organizations?

Methodology

The data collected for the purpose of this study were obtained from a sample of 180 Canadian organizations. Questionnaires were mailed to the 915 organizations listed in the directory of the Canadian Information Processing Society, after a pretest in which respondents from 10 enterprises were directly interviewed. These questionnaires were sent both to the IS manager and to his/her immediate superior. A reminder was sent to all organizations after the first mailing. Out of the 1830 questionnaires sent out, 263 were returned; this represents a response rate of 14.3% for individuals and 19.7% for organizations. The characteristics of the sampled organizations are presented in Table 2.

For the purpose of the study, respondents were provided with the following definition of end-user computing. End-user computing is the direct use of comput-

Industry	Percentage
Government	22.2
Education	19.0
Manufacturing	9.5
Insurance	8.2
Services	8.2
Health	7.0
Financial	5.7
Natural resources	4.4
Publishing	4.4
Transportation	3.2
Utilities	2.5
Others	5.7
Total	100.0

Organizational characteristics	Mean	Standard Deviation	Minimum	Maximum
I.S. budget	5 271 029$	9 273 285$	20 000$	70 000 000$
Number of employees	2706	6498	15	65 000
EUC experience (months)	71	46	4	240
Number of terminals	362	661	0	3500
Number of microcomputers	380	832	1	5000

Table 2: Sample Characteristics (N=80)

ing resources by office, professional, or managerial personnel. This personnel uses a mainframe, a mini or a microcomputer to accomplish a variety of tasks, including report generation, data analysis, problem modeling, simulation, word processing, electronic communication, etc.. This definition of the individuals who work with end-user computing excludes those whose primary task is data processing or those who work for the information systems department (Rivard and Huff, 1988). The respondents were presented with the list of 30 success criteria contained in Table 1. They were asked to rate on a five-point Likert scale the importance (1 = unimportant, 2 = not very important, 3 = important, 4 = very important, 5 = extremely important) attributed to each criterion in their actual evaluation of end-user computing in their organization (see Appendix 1). The questionnaire items were randomly distributed in order to prevent a possible methods bias. Given the literature review that preceded the elaboration of the instrument, a good case can be made for its content validity (Kerlinger, 1986).

The respondents were also presented with the following definition of the five stages of EUC growth, as proposed by Huff, Munro and Martin (1988). The stage of growth is the stage of assimilation of end-user computing technology in an organization; it is determined by the stage of end user application maturity. These stages are as follows:

Stage 1: Isolation. Little or no exchange of data or programs with other applications. They are not necessarily developed to support the user's task, but are used mostly as a learning tool.

Stage 2: Stand-alone. Applications operate in a stand-alone fashion to specifically support a user's or a small working group's task. Data entered into an application is keyed in manually.

Stage 3: Manual Integration. Data is transferred from application to application by manual file interchange (e.g., hand-carried diskette or manually controlled file transfers over a local area network or via one or more connected mainframes).

Stage 4: Automated Integration. Applications connect with one or more corporate databases and routinely transfer data between micro, workstations and mainframe databases, or among mainframes, using automated processes designed into the applications.

Stage 5: Distributed Integration. Applications are part of a network which accesses data distributed throughout the organization; distinctions concerning the location of data (e.g., whether on a microcomputer or mainframe) disappear.

The respondents were then asked to estimate the percentage of EUC applications associated with each stage, in their organization. In this regard, IS managers are considered to be key informants as to the overall end-user computing activities within their organization (Rivard and Huff, 1984; Bergeron, Rivard and De Serres, 1990; Kappelman, McLean and Thompson, 1992). Using these estimates, an end-user computing growth score for each organization was determined by the weighted sum of the proportion of applications associated with each stage, using the following formula.

$$\text{Stage of growth} = (1 * P1) + (2 * P2) + (3 * P3) + (4 * P4) + (5 * P5)$$

where $P_{i(i = 1,5)}$ = Proportion of applications at stage $_i$.

The score varies on a continuous scale of 1 to 5. Each organization was then classified in a specific stage of growth using the following cut-off points: stage 1 (1 to 1.49), stage 2 (1.50 to 2.49), stage 3 (2.50 to 3.49), stage 4 (3.50 to 4.49), stage 5 (4.50 to 5). While the two extreme stages have shorter ranges, the resulting distribution still adequately reflects the stage concept.

This way of determining the growth stage of EUC in an organization differs from the method suggested by Huff, Munro and Martin (1988). These authors suggest that the application maturity stage of an entire organization is the stage where the greatest proportion of EUC application development resources are being expended. For instance, an organization in which 45% of end-user applications are at stage 2 (stand-alone) and 55% are at stage 4 (automated integration) would be classified at stage 4. Given the wide distribution of applications among various stages in any one organization, the growth score proposed here tends to be richer and more discriminating since it takes this variance into account. Using the same example, the alternative method would result in a score of 3.1 (2*0.45 + 4*0.55) and in classifying the organization in stage 3 (2.50 <= score <= 3.49).

Results and Discussion

To determine the number and nature of the factors underlying the 30 success criteria previously identified (Table 1) and for construct validity purposes (Straub, 1989), a principal components factor analysis with varimax rotation was performed, using the data from the 263 respondents. Shown in Table 3 is the 5-

Success Criteria	Organizational Effectiveness		User Appreciation	Efficiency of Applications	Quality of Applications	Adequacy of Applications
No duplication of applications					.57	
No data redundancy					.73	
Easier access to information			.69			
Quicker access to information			.72			
More work accomplishment by users				.68		
Increase in the use of existing information systems			.45			
Improvement in organizational effectiveness	.67					
Improvement in organizational performance	.68					
Increase in the quality of decision-making		.73				
Improvement in the decision-making quality	.73					
Information systems applied to major organizational problems						.31
Low cost applications				.58		
Error free applications					.47	
Attainment of organizational objectives.	62					
Increase in data processing capacity			.43			
Increase in the quality of information			.54			
User autonomy						.63
Competitive advantage						.48
Reduction in users' work effort				.64		
Savings in the development of applications by users				.46		
Time savings				.66		
Balance between local autonomy of applications and their integration to organizational systems .51						
Effective execution of tasks				.42		
Better communication capacity			.45			
Quality of information					.55	
Quality of user databases					.55	
Cost-effectiveness of EUC as compared to other possibilities				.51		
Cost-benefits of applications				.58		
User satisfaction			.57			
Efficient use of tools by the users			.42			
Cronbach Alpha	.79		.77	.78	.67	.50
Percent of variance explained	23.4		7.3	6.3	5.3	5.0

Table 3: Factor Loadings and Reliability Coefficients (N=263)

factor structure which emerged. Each criterion clearly loaded on one factor, with the exception of one criterion with a loading of .31 whose assignment appears nonetheless to be conceptually sound and fit with the other criteria. An examination of the criteria associated with each factor, as presented in Table 4, lead to naming the factors as follows:

- organizational effectiveness, regrouping criteria related to improvements in decision-making and overall performance in the enterprise;
- user appreciation, which focusses on improvements in the access to and use of information by individuals;
- efficiency of applications, with criteria relating to improved productivity, cost and time savings brought about by end-user applications;
- quality of applications, which reflects technical design criteria for databases, outputs and processing of end-user applications;
- adequacy of applications, a more ambiguous factor, where one finds criteria that mirror the conflict between individual aims in terms of user or departmental autonomy, and organizational concerns in terms of the relevance and competitive implications of end-user computing for the enterprise.

A measure of the internal consistency of each factor, Cronbach's alpha (Table 3), confirmed that the factor structure has a sufficient level of reliability. Nunnally and Durham (1975) consider .5 to be the minimum acceptable alpha value for this type of study. For each respondent, a value was obtained for the overall importance of each factor by averaging the individual importance of the related criteria. As there were two

groups of respondents, namely IS managers and their immediate superiors, t-tests were performed to verify their homogeneity. The results indicated that there are no significant differences between the two groups as to the importance of each factor, with the exception of the fifth one, adequacy of applications (t=2.13, p=0.03). Since a lack of sample homogeneity was observed with respect to only one factor, homogeneity in the sample was assumed.

Importance of EUC Success Criteria

The five factors were ordered by decreasing importance on the basis of their mean values for the sampled organizations, as presented in Table 4, with a range of 1 (unimportant) to 5 (extremely important) for each factor. An organizational value for each factor was obtained by averaging the score of the IS manager and his superior when both scores were available. T-tests where then used to determine if significant differences existed between the mean importance of the factors. The results presented in Table 4 indicate that there is in fact a significant order of importance in the EUC success criteria. The most important component is organizational effectiveness. Then follow end-user appreciation and quality of EUC applications which are considered to be equally important. Next comes the efficiency of EUC applications. The least important component is the adequacy of EUC applications.

In view of the first research question, one can interpret these results as indicating the presence of a hierarchy of perspectives in the evaluation of end-user computing success, namely an organizational, an individual and an information resources management perspective. Given the position of the respondents, it appears that they first look at EUC from an organizational perspective, i.e. results obtained by end-users must benefit the entire organization. This conforms to a vision of EUC held by previously cited researchers such as Keen and Woodman (1984). From such a perspective, success is truly achieved only if EUC can help the organization attain its goals and achieve higher levels of performance through better decision processes and outputs.

End-user computing is next viewed from the individual end-user perspective. User satisfaction has been the most widely used systems success measure for organizational computing. It is not surprizing that the respondents recognize EUC as having emerged partly in

Factors	Mean	Standard Deviation
Organizational effectiveness	3.95	0.54
User appreciation	3.63	0.55
Quality of applications	3.63	0.50
Efficiency of applications	3.40	0.48
Adequacy of applications	3.08	0.62

Order of importance of factors [a]

	Appreciation	Quality	Efficiency	Adequacy
Effectiveness	> 7.54(0.00)	> 7.37(0.00)	> 13.56(0.00)	> 18.73(0.00)
Appreciation		= 0.06(0.95)	> 6.28(0.00)	> 12.63(0.00)
Quality			> 6.32(0.00)	> 11.16(0.00)
Efficiency				> 7.28(0.00)

Effectiveness > Appreciation = Quality > Efficiency > Adequacy

[a] T-value, probability in parenthesis

Table 4: T-test on the Importance of Factors (N=180)

	Stage 1 (N=5)		Stage 2 (N=72)		Stage 3 (N=64)		Stage 4 (N=29)		Stage 5 (N=10)		Pearson correlation between factor and growth score [a]
Factors	**Mean**	**S.d.**	**Mean**	**S.d.**	**Mean**	**S.d.**	**Mean**	**S.d.**	**Mean**	**S.d.**	
Organizational effectiveness	3.88	.42	3.84	.61	3.99	.54	4.10.	48	4.15	.36	.18 (.01)
User appreciation	3.79	.29	3.55	.55	3.69	.46	3.75	.46	3.56	.51	.06 (.20)
Quality of applications	3.87	.32	3.54	.59	3.64	.52	3.75	.43	3.81	.73	.16 (.02)
Efficiency of applications	3.50	.22	3.32	.52	3.41	.43	3.51	.48	3.52	.61	.13 (.04)
Adequacy of applications	3.31	.55	2.98	.69	3.15	.53	3.15	.57	3.15	.75	.07 (.17)

Order of importance of factors within each stage [b]

Stage 1 Effectiveness = Appreciation = Quality = Efficiency = Adequacy
Stage 2 Effectiveness > Appreciation = Quality > Efficiency > Adequacy
Stage 3 Effectiveness > Appreciation = Quality > Efficiency > Adequacy
Stage 4 Effectiveness > Appreciation = Quality > Efficiency > Adequacy
Stage 5 Effectiveness > Appreciation = Quality = Efficiency > Adequacy

[a] The number in parenthesis represents the degree of significance [b] > Indicates that the T-test is significant at 0.05

Table 5: Relationship Between Importance of Factors and Growth Stages (N=180)

response to the failures of organizational computing and, as such, is an individual process which should better satisfy the end-user's information needs. EUC success is thus achieved if end-users are satisfied with this process in terms of their computing tools, their access to information and their capacity to analyze or communicate this information.

The last three components of EUC success are seen from an information resources management (IRM) perspective. From this point of view, the quality of EUC applications is thought to be as important as user satisfaction. As end-user computing requires an increasing proportion of available information resources and can entail important risks (Davis, 1982; Alavi and Weiss, 1985), the technical quality of user-developed outputs, databases and programs is also primordial to the organization. For instance, individual, departmental or organizational decisions based on false information resulting from unvalidated data or incompletely tested models may result in serious problems. The preoccupation with this aspect of EUC success is related with the organizational and individual aspects, in the sense that applications can contribute to organizational effectiveness and satisfy end-users only if they are of sufficient quality.

From the same IRM perspective, the sampled organizations indicate the efficiency of EUC applications to be less important. This component basically refers to the cost-time reductions and productivity increases obtained by end-users. It is often illusory to justify an information system project on purely tangible benefits, and probably more so in the case of EUC applications. Thus, for the managers, professionals and knowledge workers who develop and use these applications, the impact of EUC privileged by the organization would be more in terms of satisfying information needs and amplifying decision-making capacities. Finally, as to the least importance given the adequacy component, it seems that EUC applications are not viewed as having a great capacity to solve major organizational problems, provide the organization with a competitive advantage or otherwise replace organizational information systems. Instead, EUC would be more of a complement than a substitute by giving the type of support which cannot be given by the organizational computing function. This last interpretation is tentative, however, given that this last component has somewhat less internal consistency than the other four.

Success Criteria and EUC Growth

The initial EUC growth score was calculated on a continuous scale for the 180 sampled organizations, and each was then categorized in one of five stages, based on the previously described formula. On the continuous scale, the mean EUC growth score was 2.81, with a standard deviation of 0.86 and a range of 1.00 to 5.00. Only 5 organizations were found to be in stage 1 and 10 in stage 5. The majority were found to be in stages 2, 3 and 4 with 72, 64 and 29 organizations respectively. To test the validity of the model, on a temporal basis at least, the growth score was correlated with the EUC experience of the organization (number of months), the result being positive with a product-moment coefficient of 0.37 (n=180, p=.000).

As shown in Table 5, the mean importance of the five components of EUC success was calculated within each stage. In view of the second research question, the order of the components within one stage can be compared with the overall order (Table 4) and with other stages to ascertain if the relative importance of certain success criteria changes as EUC grows within the organization. Looking at the mean values presented in Table 5, one can see that the order of importance basically remains the same within each stage and is identical to the overall order, i.e. organizational effectiveness, user appreciation, applications quality, efficiency and adequacy. The results of t-tests confirm the significance and the similarity of this order within all but the first stage, as shown in Table 5. In stage 1, no component differs significantly from any other as there are only five organizations.

These results do not support the notion that organizations emphasize different success criteria as end-user computing grows and matures. From the suggestions and findings of previously cited researchers, one would have expected that end-user satisfaction would be the predominant consideration in the early stages, and that the quality and efficiency of EUC applications would become primordial at more advanced stages. Finally, only in the mature stages would organizational effectiveness become most important.

A possible explanation could reside in the nature of the questions asked to the respondents, and in their position and hierarchical level, i.e. the manager of the organizational computing function and his superior who is a top-level executive in most cases. Their answers would reflect an *a priori* vision of EUC evaluation which could originate mainly with their previous experience of organizational computing. This vision would tend to remain the same, favoring the organizations over the end-user, and quality over efficiency.

There might also be problems with the validity of the EUC stage model used in the present study, or at least with the way in which it was operationalized. The fact that a small number of firms could be found in either the first or last stage might indicate that stage benchmark variables other than the nature of end-user computing applications are needed to better describe EUC growth processes. Using an alternative model such as the one proposed by Magal, Carr and Watson (1988) could have produced different findings.

In addition to the preceding results, we can look at the changes in the importance of the EUC success criteria in absolute rather than in relative terms. This was done by correlating the organizational scores for each success component with the EUC growth score. The values of the correlation coefficients presented in the right-hand column of Table 5 indicate that the emphasis placed on organizational effectiveness, quality and efficiency of applications increases significantly as EUC matures within the organization. This could also be seen as evidence for the predictive validity of the EUC assessment measure, albeit to the extent the growth of EUC can be attributed to its previous success in an organization (Henderson and Treacy, 1986).

As the variety, complexity, diffusion and integration of EUC applications progressively increases, the development and usage of such applications by end-users tend to affect more of the essential processes, functions and activities of the organization. This is accompanied by an increasing allocation of information resources to support end-user computing. The organization's stake in the success of EUC thus becomes progressively greater as it moves from stage to stage, and could explain why an increasing emphasis would be put on the success criteria pertaining to organizational effectiveness and to the management of end-user computing.

Limitations and Conclusions

While the primary objective of this study was not to develop a measure of EUC success, the results suggest that the instrument used here constitutes an initial version of such a measure. Further iterations would be required to increase reliability and validity of the instrument. Apart from the additional validation needed for the model of EUC growth used in this research, another limitation which must be mentioned is the cross-sectional nature of the study. Only through

longitudinal investigations can we hope to fully understand how the success of end-user computing is and should be measured as it spreads through the organization and evolves in complexity. In addition to what is wished and needed by organizations, we should try to increase our knowledge of the EUC evaluation practices actually employed, and how these practices actually change over time.

In conclusion, this study empirically found a definite order of importance in criteria on which to evaluate the success of end-user computing from an organizational perspective. In order of decreasing importance, these criteria pertain to organizational effectiveness, end-user appreciation, the quality of EUC applications, the efficiency of EUC applications, and the adequacy of EUC applications. This order remains the same whatever the stage of EUC growth attained. However, the emphasis placed on organizational effectiveness, and on the quality and efficiency of applications increases as EUC matures within the organization. These results will have to be added to, however, as better definition and measurement of end-user computing success become a pre-requisite to further theoretical and practical advances in this area.

Appendix 1 Instrument Used to Measure Success Criteria with Rankings

Question: Please indicate the level of importance for each of the following criteria with regards to the success of end-user computing in your organization

	Unimportant	Not Very Important	Important	Very Important	Extremely Important	Mean
- Quality of information						4.51
- No data redundancy						3.17
- Achievement of organizational objectives						3.97
- Increase in the quality of decision-making						3.98
- No duplication of applications						3.14
- Improvement of organizational performance						3.97
- User satisfaction						4.09
- Improvement in organizational effectiveness						3.99
- Time savings						3.70
- More work accomplishment by users						3.78
- Increase in data processing capacity						2.98
- Quicker access to information						3.89
- Efficient use of computer tools by the users						3.50
- Easier access to information						3.87
- Better communication capacity						3.52
- Increase in the use of existing information systems						3.25
- Cost-benefits of applications						3.56
- Reduction in users' work effort						3.44
- Low cost applications						2.93
- Balance between autonomy of applications and their integration to organizational systems						3.16
- Increase in the quality of information						4.04
- Improvement in decision-making quality						3.99
- Quality of user databases						3.65
- Competitive advantage						3.03
- User autonomy						3.00
- Information systems applied to major organizational problems						3.24
- Error free applications						3.67
- Savings in the development of applications by users						3.10
- Cost effectiveness of end-user computing compared to other possibilities						3.25
- Effective execution of tasks						3.60

References

Aberth, J., "Can you Justify Computers?," *Information Center*, Vol. 3, No. 3, March 1987, pp. 50-53.

Alavi, M., "End-User Computing: The MIS Managers' Perspective," *Information and Management*, Vol. 8, 1985a, pp. 171-178.

Alavi, M., "Some Thoughts on Quality Issues of End-User Developed Systems," *Proceedings of the 21st Annual Computer Personnel Conference*, Minneapolis, Minnesota, May 1985b, pp. 200-207.

Alavi, M., Nelson, R.R., Weiss, I.R., "Strategies for End-User Computing : An Integrative Framework," *Journal of Management Information Systems*, Vol. 4, No. 3, Winter 1987-1988, pp. 28-49.

Alavi M., Phillips, J.S., Freedman, S.M., "Strategy for Control of End-User Computing: Impact on End-Users", *Proceedings of the 7th International Conference on Information Systems*, San Diego, 1986, pp. 57-66.

Alavi, M., Weiss, I.R., "Managing the Risks Associated with End-User Computing," *Journal of Management Information Systems*, Vol. 2, No. 3, Winter 1985-1986, pp. 5-20.

Alavi, M., Phillips, J.S., Freedman, S.M., "An Empirical Investigation of Two Alternative Approaches to Control of End-User Application Development Process," *Data Base*, Vol. 20, No. 3, Winter 1990, pp. 11-19.

Amoroso, D.L., *Effectiveness of End-User Developed Applications in Organizations: an Empirical Investigation*, Unpublished Ph.D. Dissertation, The University of Georgia, Athena, Georgia, 1986.

Amoroso, D.L., "Organizational Issues of End-User Computing", *Data Base*, Vol. 19, No. 3/4, Fall/Winter 1988, pp. 49-57.

Beheshtian, M., Van Wert, P.D., "Strategies for Managing User Developed Systems," *Information & Management*, Vol. 12, 1987, pp. 1-7.

Benbasat, I., Dexter, A.S., Drury, D.H., Goldstein, R.C., "A Critique of the Stage Hypothesis: Theory and Empirical Evidence", *Communications of the ACM*, Vol. 27, No. 5, May 1984, pp. 476-485.

Benjamin, R.I., "Information Technology in the 1990s: A Long-Range Planning Scenario", *MIS Quarterly*, June 1982, pp. 11-31.

Benson, D.H., "A Field Study of End User Computing: Findings and Issues", *MIS Quarterly*, Vol. 7, No. 4, December 1983, pp. 35-46.

Bergeron, F., Bérubé, C.., "The Management of the End-User Environment: an Empirical Investigation", *Information & Management, 14* (1988), pp. 107-113.

Brittain White, K., "Current Technology Practices: Perspectives From Information Systems Managers", *SIM Spectrum*, Vol. 3, No. 6, December 1986.

Brown, C.V., Bostrom, R.P., "Effective Management of End-User Computing: A Total Organization Perspective," *Journal of Management Information Systems*, Vol. 6, No. 2, Fall 1989, pp. 77-92.

Brown, C.V., Brancheau, J.C., "A Research Model for Managing End-User Computing: Making Sense of the Past Decade," *Proceedings of the Hawaii Twenty Fifth International Conference on System Sciences*, Vol III, 1992, pp. 269-276.

Cheney, P.H., Mann, R.I., Amoroso, D.L., "Organizational Factors Affecting the Success of End-User Computing," J*ournal of Management Information Systems*, Vol. 3, No. 1, Summer 1986, pp. 65-80.

Corman, L.S., " Data Integrity and Security of the Corporate Data Base: The Dilemna of End-User Computing," *Data Base*, Vol. 19, No. 3/4, Fall/Winter 1988, pp. 1-6.

Davis, G.B., "User-Developed Decision Support Systems Can Be Dangerous to Your Organization", *Computerworld*, Special Report, April 26, 1982.

Doll, W.J., Torkzadeh, G., "A Discrepancy Model of End-User Computing Involvement," *Management Science*, Vol. 35, No. 10, October 1989, pp. 1151-1171.

Doll, W.J., Torkzadeh, G., "The Measurement of End-User Computing Satisfaction", *MIS Quarterly*, Vol. 12, No. 2, June 1988, pp. 259-276.

Ein-Dor, P., Segev, E., "Intensity of End-User Computing, *Data Base*, Vol. 22, No. 1/2, Winter/Spring 1991, pp. 30-37.

Evans, R., "Reaping the Full Benefits of End-user Computing", *Computerworld-In Depth*, Vol. 23, No. 34, August 21, 1989, pp. 67-71.

Fuerst, W.L., Martin, M.P., "Effective Design and Use of Computer Decisions Models", *MIS Quarterly*, Vol. 8, No. 1, March 1984, pp. 17-26.

Gattiker, U.E., Paulson, D., "The Quest for Effective Teaching Methods: Achieving Computer Literacy for End-Users", *Infor*, Vol. 25, No. 3, August 1987, pp. 236-255.

Gerrity, T.P., Rockart, J.F., "End-User Computing: Are You a Leader or a Laggard?", *Sloan Management Review*, Summer 1986, pp. 25-34.

Guimaraes, T., "The Benefits and Problems of User Computing," *Journal of Information Systems Management*, Fall 1984, pp. 3-9.

Henderson, J.C., Treacy, M.E., "Managing End-User Computing for Competitive Advantage", *Sloan Management Review*, Winter 1986, pp. 3-14.

Huber, G.P., "The Nature of Organizational Decision Making and The Design of Decision Support Systems", *MIS Quarterly*, Vol. 5, No. 2, June 1981, pp. 1-10.

Huff, S. L., Munro, M. C., Martin, B. H., "Growth Stages of End User Computing", *Communications of The ACM*, Vol. 31, No. 5, May 1988, pp. 542-550.

Jarvenpaa, S. L., Machesky, J. J., "End User Learning Behavior in Data Analysis and Data Modeling Tools", *Proceedings of the Seventh International Conference on Information Systems*, San Diego, December 1986, pp. 152-167.

Kappelman, L.A., McLean, E.R., Thompson, J.P., "End-User Computing Reexamined," IRSC-WP-910201, University of North Texas, 1991.

Kasper, G.M., "The Effect of User-Developed DSS Applications on Forecasting Decision-Making Performance in an Experimental Setting," *Journal of Management Information Systems*, Vol. 2, No. 2, 1985, pp. 26-39.

Kasper, G.M., Cerveny, R.P., "A Laboratory Study of User Characteristics and Decision-Making Performance in End-User Computing," *Information & Management*, Vol. 9, 1985, pp. 87-96.

Keen, P., "A Policy Statement for Managing Microcomputers", *Computerworld*, Vol. 17, No. 20, May 1983, pp. 35-39

Keen, P., Woodman, L.A., "What To Do With All Those Micros?", *Harvard Business Review*, September-October 1984, pp. 142-150.

Kerlinger, F.N., *Foundations of Behavioral Research*, 3rd Edition, Holt Rinehart Winston, 1986.

Klepper, R., Sumner, M., "Continuity and Change in User Developed Systems," *Desktop Information Technology*, K.M. Kaiser and H.J. Oppelland (eds), North Holland, 1990, pp. 209-222.

Kosimar, P.T., "A Proactive Approach to End-User Computing", *SIM Spectrum*, Vol. 4, No. 2, April 1987.

Magal, S.R., "The Evolution of Information Centers: A Stage Hypothesis",

Data Base, Vol 20, No. 1, Spring 1989, pp. 39-46.

Magal, S. R., Carr, H. H., Watson, H. J., "Critical Success Factors for Information Center Managers", *MIS Quarterly*, Vol. 12, No. 3, September 1988, pp. 413-425.

Mahmood, M.A., Becker, J.D., "Effect of Organizational Maturity on End-Users' Satisfaction with Information Systems", *Journal of Management Information Systems*, (2:3), Winter 1985-86, pp. 37-64.

McKenney, J.L., McFarlan, F.W., "The Information Archipelago - Maps and Bridges", *Harvard Business Review*, Vol. 60, No. 5, September-October 1982, pp. 109-119.

McLean, E.R., "End-Users as Applications Developers", *MIS Quarterly*, Vol. 3, No. 4, December 1979, pp. 37-46

Nolan, R.L., "Managing the Crises in Data Processing," *Harvard Business Review*, Vol. 57, No. 2, March-April 1979

Nunnally, J.C., Durham, R.L., "Validity, Reliability and Special Problems of Measurement in Evaluative Research," in Struening, E.L., and Guttentag, M., (eds), *Handbook of Evaluation Research*, Beverly Hills, California: Sage Publications, 1975, pp. 289-354.

Painter, W.J., "Introducing Micros into Large Organizations: Checklist of Problems and Solutions," *Journal of Management Information Systems*, Vol. 5, No 1, Winter 1988, pp. 29-32.

Pentland, B.T., "User and Productivity in Personal Computing: An Empirical Test," *Proceedings of the Tenth International Conference on Information Systems*, Boston, MA, 1989, pp. 211-222.

Porter, L.R., "Managing The Diffusion of End-User Computing Technologies: A Fifties Mindset With The Eighties Tools", *Managers, Micros and Mainframes, The 1985 NYU Symposium on Integrating Systems for End-Users*, May 22-24, 1985, New York City.

Quillard, J.A., Rockart, J.F., "Looking at Micro-User", *Computerworld*, Vol. 18, No. 33A, August 15, 1984, pp. 11-15.

Raymond, L., "The Presence of End-User Computing in Small Business: An Exploratory Investigation of its Distinguishing Organizational and Information Systems Context," *Infor*, Vol. 25, No. 3, 1987, pp. 198-213.

Raymond, L., "End-User Computing in the Small Business Context: Foundations and Directions for Research," *Data Base*, Vol. 20, No. 3, Winter 1990, pp. 20-28.

Raymond, L., Bergeron, F., "Personal DSS Success in Small Organizations," *Information & Management*, 22, 1992 pp. 301-308.

Raymond, L., Bergeron, F., Gingras, L., Rivard, S., "La Qualité des Applications de la Micro-informatique: Les Utilisateurs Sont-ils de Bons Concepteurs?", *Gestion - Revue internationale de gestion*, Novembre 1988, Vol. 13, No. 4, pp. 34-40.

Rivard, S., Huff, S.L., "An Empirical Study of Users as Application Developers", *Information & Management*, Vol. 8 No. 2, February 1985, pp. 89-102.

Rivard, S., Huff, S. L., "User Developed Applications: Evaluation of Success from the DP Department Perspective", *MIS Quarterly*, Vol. 8, No. 1, March 1984, pp. 39-49.

Rivard, S., Huff, S.L., "Factors of Success for End-User Computing", *Communications of the ACM*, Vol. 31, No. 5, May 1988, pp. 552-561.

Rivard, S., Lebrun, P., Talbot, J., "Measuring the Quality of User-Developed Applications," *Proceedings of the 24th Annual Hawaii Conference on Systems Sciences*, Vol III, 1991, pp. 471-478.

Rockart, J. F., Flannery, L. S., "The Management of End User Computing", *Proceedings of The Second International Conference an Information Systems*, Cambridge, Mass., December 1981, pp. 351-363.

Rockart, J. F., Flannery, L. S., "The Management of End-user Computing", *Communications of the ACM*, Vol. 26, No. 10, October 1983, pp. 785-793.

Straub, D.W., "Validating Instruments in MIS Research," *MIS Quarterly*, Vol. 13, No. 2, June 1989, pp. 147-170.

Sein, M., Bostrom, R.P., "Training End Users to Compute: Cognitive, Motivational and Social Issues", *Infor*, Vol. 25, No. 3, August 1987, pp. 236-255.

Sumner, M., "Organization and Management of the Information Center: Case Studies"; *Proceedings of the 21st Annual Computer Personnel Conference*, Minneapolis, Minnesota, May 1985, pp. 38-48.

Sumner, M., Klepper, R., "Information Systems Strategy and End-User Application Development", *Data Base*, Volume 18, No. 4, Summer 1987, pp. 19-30.

Wetherbe, J., Leitheiser, R. L., " A Survey of Information Centers: Services, Decisions, Problems, and Processes", *Journal of Information Systems Management*, Vol. 2, No. 3, Summer 1985.

Yaverbaum, G.J., "Critical Factors in the User Environment: An Experimental Study of Users, Organizations and Tasks," *MIS Quarterly*, Vol. 12, No. 1, March 1988, pp. 75-88.

François Bergeron is Professor and Director of the Département des systèmes d'information organisationnels, Université Laval, Québec. His current research and consulting activities focus on the management of information technologies and on the measurement of the business value of information systems. Professor Bergeron has published in journals such as MIS Quarterly, Journal of Information Systems, Information & Management, and Journal of Management Information Systems. He also co-authored three books on information systems, the last one titled "Informatiser son entreprise" in collaboration with R. Reix and L. Raymond. He received his PhD in Management from the University of California, Los Angeles.

Louis Raymond is Professor of Information Systems at the Département of Administration and Economics, Université du Québec à Trois-Rivières, Quebec, Canada. His current research interests relate to organizational information systems and end-user computing. He has published articles in various journals such as MIS Quarterly, Information & Management, American Journal of Small Business, Journal of Systems Management, and Data Base. He has also co-authored books on information systems and office automation

Suzanne Rivard is a Professor in Information Systems at the Ecoles des Hautes Etudes Commerciales, in Montréal. She received an MBA from the Ecoles des Hautes des Commerciales, and a Ph.D. in Information Systems, from the School of Business Administration, The University of Ontario. Her research interests include end-user computing, user development of computer-based applications, and the management of systems development projects. She published articles in Communications of the ACM, Information & Management, Interfaces and MIS Quarterly. She currently serves as an Associate Editor for Information Systems Research and the MIS Quarterly.