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The Application Development Process:What Role does it Play in the Success of an Application for the User Developer?

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Abstract

End user development of applications forms a significant part of organisational systems development. This study investigates the role that developing an application plays in the eventual success of the application for the user developer. The results of this study suggest that the process of developing an application not only predisposes an end user developer to be more satisfied with the application than they would be if it were developed by another end user, but also leads them to perform better with it. Thus the results of the study highlight the contribution of the process of application development to application success.

Keywords

User satisfaction, Measuring IS success, User development, End-user computing, End users

INTRODUCTION

An end user developer is someone who develops applications systems to support his or her work or the work of other end users. The applications developed are known as user developed applications (UDAs). So, while the technical abilities of user developers may vary considerably, they are basically required to analyse, design and implement applications. End user development of applications forms a significant part of organisational systems development, with the ability to develop small applications forming part of the job requirements for many positions (Jawahar & Elango 2001).

Much has been written about the potential benefits and risks of end user development. In their review of the literature, Brancheau and Brown (1993) identified a number of possible benefits of user development of applications. These included better and more timely access to information, improved quality of information, improved decision making, improved information systems department/user relationships, and lower system development costs. In the early UDA literature the proposed benefits of UDA were seen to flow from a belief that the user has a superior understanding of the problem to be solved by the application system (Amoroso 1988).

Despite the potential benefits to an organisation of user development of applications there are many risks associated with it that may lead to potentially dysfunctional consequences for the organisation's activities. These risks result from a potential decrease in application quality and control as individuals with little information systems training take responsibility for developing and implementing systems of their own making (Cale 1994), and include ineffective use of monetary resources, threats to data security and integrity, solving the wrong problem (Alavi & Weiss 1985-1986), unreliable systems, incompatible systems, and use of private systems when organisational systems would be more appropriate (Brancheau & Brown 1993).

The literature on user participation and involvement also proposes benefits that are thought to accrue from greater inclusion of users in the system development process. The benefits that have been proposed include higher levels of information system usage, greater user acceptance of systems, and increased user satisfaction (Lin & Shao 2000). The end user's superior knowledge of the problem to be solved is certainly one factor influencing these benefits, but the process of participating per se is also thought to have benefits. Those who have participated have a greater understanding of the functionality of the resulting application (Lin & Shao 2000) and a greater sense of involvement with it (Barki & Hartwick 1991), and hence a greater commitment to making it successful. User development of applications has been described as the ultimate user involvement (Cheney, Mann, & Amoroso 1986). It could thus be expected to lead to systems that gain the benefit of a better understanding of the problem, and to end users with a better understanding of the application and greater commitment to making it work.

The literature on organisational information systems effectiveness has proposed numerous measures of success. These include user satisfaction (e.g. Nelson & Cheney 1987), decision making performance (e.g. Fuerst &

Cheney 1982) and frequency of use (e.g. Srinivasan 1985). DeLone and McLean (1992) provide examples of many more measures. The use of such a variety of measures has been problematic. Firstly the value of some measures is doubtful (Melone 1990; Trice & Treacy 1988) and secondly comparison between studies has been difficult due to variations in measures used.

Research on UDA success has been less widespread (Shayo, Guthrie, & Igbaria 1999), but in a similar fashion a number of possible measures have been considered. Empirical studies on UDA success suggest that, as might be expected, applications developed by end user developers are of lower quality than those developed by information systems professionals (Edberg & Bowman 1996), however end user developers perceive their applications to be of higher quality on some dimensions than do independent assessors (McGill in press). This is exacerbated when the end user has little experience or training (McGill in press).

Doll and Torkzadeh (1989) found much higher involvement scores for end user developers than for users who were involved in the development process but where the application was primarily developed by a systems analyst or another end user. End user developers were also found to be more satisfied with applications they had developed themselves than with applications developed by another end user (McGill, Hobbs, Chan, & Khoo 1998) or with applications developed by a systems analyst (despite involvement in the systems development process) (Doll & Torkzadeh 1989).

In early studies of the impact of the introduction of end user development into organisations Rivard and Huff reported significant productivity gains (Rivard & Huff 1985) and Cronan and Douglas (1990) reported that savings of around 7 hours per week were claimed by end users. In a laboratory experiment, Kasper (1985) also identified improvements in both decision accuracy and speed by end user developers when compared to end users using existing decision support tools.

This paper investigates the role that actually developing an application plays in the eventual success of the application for the user developer.

RESEARCH QUESTIONS

The primary research question investigated in this study was:

> - Does the process of developing an application enhance the success of that application for the user developer?

The study compares end user developers using their own applications for decision making with end users using applications developed by another end user on a number of key variables that have been considered in the information systems success literature.

It was hypothesised that:

H1: End user developers will perceive their own applications to be of higher system quality than applications developed by another end user with a similar level of spreadsheet knowledge.

H2: End user developers will have higher levels of involvement with their own applications than with applications developed by another end user with a similar level of spreadsheet knowledge.

H3: End user developers will have higher levels of user satisfaction when using their own applications than when using applications developed by another end user with a similar level of spreadsheet knowledge.

H4: End user developers will have higher levels of perceived individual impact when using their own applications than when using applications developed by another end user with a similar level of spreadsheet knowledge.

H5: End user developers will make more accurate decisions when using their own applications than when using applications developed by another end user with a similar level of spreadsheet knowledge.

H6: End user developers will make faster decisions when using their own applications than when using applications developed by another end user with a similar level of spreadsheet knowledge.

METHOD

Subjects

The target population for this study was end users who develop their own applications using spreadsheets. In order to obtain a sample of end user developers with a wide range of backgrounds, participants were recruited for the study by in a variety of ways. It was recognised that the time required for participation (see below) would

make recruitment difficult, so participants were offered a one hour training course entitled 'Developing Spreadsheet Applications' as an incentive. This session focussed on spreadsheet planning, design and testing. They were also given $20 to compensate them for parking costs, petrol and inconvenience. Recruitment occurred firstly through a number of advertisements were placed in local newspapers calling for volunteers, these were-followed by e-mails to three large organisations that had expressed interest in the study and finally word of mouth brought forth some additional participants. The criteria for inclusion in the study was previous experience using Microsoft Excel. Whilst being essentially a convenience sample, the participants covered a broad spectrum of ages, spreadsheet experience and training.

Procedure

Fourteen separate experimental sessions of approximately 4 hours were held over a period of 5 months. Each session involved between 7 and 17 participants (depending on availability). Each experimental session consisted of 3 parts.

In Part 1 participants were asked to complete a questionnaire to provide demographic information about themselves and information about their background with computers and spreadsheets. The questionnaire also tested their knowledge of spreadsheets.

In Part 2 the participants were given a problem statement and asked to develop a spreadsheet to solve it using Microsoft Excel. The problem related to making choices between car rental companies. Participants were provided with blank paper to use for planning if they wished, but otherwise were left to develop the application as they wished. They were encouraged to treat the development exercise as they would a task at work, rather than as a test. Participants could use on-line help or ask for technical help from the two researchers present in the laboratory during each session.

Once all participants in the session had completed their spreadsheet they undertook Part 3 of the session. Each participant was given a floppy disk containing both the spreadsheet they had developed and a spreadsheet from another participant in the session. Matching was done on the basis of the spreadsheet knowledge scores from Part 1 in the expectation that participants with a similar level of spreadsheet knowledge would develop spreadsheets of similar sophistication.

To control for presentation order effects, each participant was randomly assigned to use either their own or the other spreadsheet first. They then used the spreadsheet to answer 10 questions relating to making choices about car rental hire. The time taken to answer these questions was recorded. They then completed a questionnaire containing items to measure: perceived system quality, involvement, user satisfaction and perceived individual impact. Once the questionnaire and their answers to the car rental decision questions were collected each participant then repeated the process with the other spreadsheet on their floppy disk. A different but equivalent set of car rental decision questions was used.

Instruments

The development of the research instruments for this study involved a review of many existing survey instruments. To ensure the reliability and validity of the measures used, previously validated measurement scales were adopted wherever possible.

Spreadsheet application development knowledge

Spreadsheet application development knowledge relates to the knowledge that end user developers make use of when developing UDAs. The instrument used to measure spreadsheet development knowledge was based upon an instrument used by McGill and Dixon (2001). That instrument was developed using material from several sources including: Kreie's (1998) instrument to measure spreadsheet features knowledge; spreadsheet development methodologies from Ronen, Palley and Lucas (1989) and Salchenberger (1993); and Rivard et al.'s (1997) instrument to measure the quality of UDAs. The final instrument contained 25 items. Each item was presented as a multiple choice question with 5 options. In each case the 5th option was 'I don't know' or 'I am not familiar with this feature'. Nine of the items related to knowledge about the features and functionality of spreadsheet packages, 8 items related to development process and 8 items related to spreadsheet quality assurance. The instrument was shown to be reliable with a Cronbach's alpha of 0.78 (Nunnally 1978).

Involvement

Involvement is a subjective psychological state reflecting the importance and personal relevance of a system to the user (Barki & Hartwick 1991). The involvement construct was operationalised using Barki and Hartwick's (1991) instrument. They developed the scale for information systems based on the general involvement scale

proposed by Zaichkowsky (1985). The resulting scale is a seven point bi-polar semantic differential scale with 11 items. The instrument as used in this study, was shown to be reliable with a Cronbach's alpha of 0.96.

Perceived system quality

The items used to measure perceived system quality were obtained from the instrument developed by Rivard et al (1997) to assess the quality of user developed applications. Rivard et al.'s instrument was designed to be suitable for end user developers to complete, yet to be sufficiently deep to capture their perceptions of components of quality. For this study, items which were not appropriate for the applications under consideration (e.g. specific to database applications) were excluded. Minor adaptations to wording were also made to reflect the environment in which application development and use occurred. The resulting system quality scale consisted of 20 items, each scored on a Likert scale of 1 to 7 where (1) was labelled 'strongly agree' and (7) was labelled 'strongly disagree'. The instrument was shown to be reliable with a Cronbach's alpha of 0.93.

User satisfaction

Given the confounding of user satisfaction with information quality and system quality in some previous studies (Seddon & Kiew 1996), items measuring only user satisfaction were sought. Seddon and Yip's (1992) 4 item 7 point semantic differential scale that attempts to measure user satisfaction directly was used in this study. A typical item on this scale is 'How effective is the system?', measured from (1) 'effective' to (7) 'ineffective'. The instrument was shown to be reliable with a Cronbach's alpha of 0.96.

Perceived individual impact

In this study it was explicitly recognised that an individual's perception of the impact of an information system on their performance may not be consistent with other external measures of individual impact. Perceived individual impact was measured using items derived from Goodhue and Thompson (1995) and also used by Goodhue, Klein, and March (2000) in their study on user evaluations of systems as surrogates for objective performance. The instrument was shown to be reliable with a Cronbach's alpha of 0.96.

Individual impact

DeLone and McLean (1992) claimed that individual impact is the most difficult information systems success category to define in unambiguous terms. For example, the individual impact of an UDA could be related to a number of measures such as impact on performance, understanding, decision making or motivation. Given that perceived individual impact was also a construct in the study a decision was made to focus on 'objective' easily quantifiable aspects of individual impact. Individual impact was measured in two different ways: accuracy of decision making (number of questions correct) and time taken to answer a set of questions. These measures were also used by Goodhue, Klein, and March (2000) in their study on user evaluations of systems.

Two sets of 10 different but equivalent questions involving the comparison of costs of car rental companies under a variety of scenarios were created. The questions ranged from comparison of the three firms when no excess kilometre charges are imposed through to questions where excesses are applied and basic parameters are assumed to have changed from those given in the original problem description. A typical question is 'Which rental company is the cheapest if you wish to hire a car for 6 days and drive approximately 1500 kilometres with it?' Participants were asked to provide both the name of the cheapest firm and its cost. The questions were piloted by four end users and slight changes made to clarify them.

RESULTS

Of the 159 participants, 32.7% were male and 67.3% female (52 males, 107 females). Their ages ranged from 14 to 77 with an average age of 42.7. Participants reported an average of 4.5 years experience using spreadsheets (with a range from 0 to 21 years). One hundred and twelve (70.4%) used spreadsheets at work and 92 (57.9%) used spreadsheets for personal use.

Table 1 below provides descriptive information about each of the variables of interest. Each of the hypotheses was addressed using paired-samples t-tests where each end user's interaction with their own application was directly compared with their interaction with another UDA (Table 1). End users perceived their own applications to be of higher quality than applications developed by other end users. On average there was a 15.5% difference in perceived quality when the developer was assessing his/her own application. This increase was significant ($t = 4.21$, $df = 156$, $p < 0.001$). End user developers were also significantly more involved with their own applications ($t = 4.93$, $df = 156$, $p < 0.001$) and significantly more satisfied with them ($t = 3.43$, $df = 156$, $p = 0.001$). The average increase in involvement if the user was also the developer was 15.0% and the average increase in user satisfaction was 21.9%. Thus Hypotheses 1 to 3 were supported.

		Developer + User		User Only		Comparison	
	N	*Mean*	*Std. dev.*	*Mean*	*Std. dev*	*% incr.*	*Sign.*
Perceived system quality	157	4.62	1.28	4.00	1.48	15.5	0.000
Involvement	157	9.41	2.69	8.18	3.19	15.0	0.000
User satisfaction	157	4.45	1.85	3.65	2.07	21.9	0.001
Perceived individual impact	157	9.38	3.92	7.29	4.31	28.7	0.000
Number of decisions correct (/10)	157	4.43	3.33	3.49	3.22	26.9	0.002
Time to make decisions (minutes)	154	17.62	10.00	15.22	7.21	15.8	0.020

Table 1: End user developer perceptions and performance when using their own or another application

End users perceived their own applications as having a significantly greater impact on their decision performance ($t = 4.35$, $df = 156$, $p < 0.001$) and this was confirmed as they made a significantly larger number of correct decisions ($t = 3.08$, $df = 156$, $p = 0.002$). The average increase in perceived individual impact of the application was 28.7% and the average difference in the number of decisions correct was 26.9%. Thus Hypotheses 4 and 5 were supported. It was also hypothesised that end user developers would make faster decisions when using the application they had developed themselves. However this hypothesis was not supported. End users took significantly longer to answer the questions using their application ($t = 2.36$, $df = 153$, $p = 0.02$). On average the difference in decision time was 15.8%.

DISCUSSION

The results of this study suggest that the process of developing an application not only predisposes an end user developer to be more satisfied with the application than they would be if it were developed by another end user, but also leads them to perform better with the application than they would if it were developed by another end user. The results of the study also highlight the contribution of the process of application development to application success. This contribution appears to be beyond the advantages achieved by an increased knowledge of the problem situation. Thus end user developers benefit not only from better understanding of the problem to be solved (Amoroso 1988), but also from the process of application development.

The end user developers in this study had significantly higher levels of involvement, user satisfaction and perceived individual impact when using their own applications than they did when using applications developed by another end user with approximately the same levels of spreadsheet development knowledge. They also perceived their applications to be of higher system quality. These results are consistent with the results in the literature on user involvement in the development of organisational systems. For example, Doll and Torkzadeh (1988) found user participation in design to be positively correlated with end user computing satisfaction, and Lawrence and Low (1993) found that the more a user felt involved with the development process, the more satisfied they were with the system. The results are also consistent with McGill et al's (1998) study in the end user developer domain, where end user developers were found to be more satisfied with their own applications.

The results also confirm Cheney, Mann and Amoroso's (1986) claim that end user development can be considered as the ultimate user involvement. The higher levels of perceived system quality for end users' own applications highlight the subjectivity of system quality for end users. This issue has been raised by Huitfeldt and Middleton (2001) who argued that the standard system quality criteria are oriented towards information technology maintenance staff rather than end users and that 'it is still difficult for an end user, or software development client, to evaluate the quality of the delivered product' (p. 3). Although the instrument used to measure perceived system quality in this study was designed specifically for end users (Rivard et al. 1997) informal feedback from participants suggests they found quality assessment a difficult task. In contrast to 'software engineering' definitions of system quality (e.g. Boehm et al. 1978), Amoroso and Cheney (1992) implicitly acknowledge the difficulty by defining UDA quality as a combination of end user information satisfaction and application utilisation. This however, ignores the underlying necessity for the more technical dimensions of system quality to be taken account of in order to have reliable and maintainable applications.

End user developers made significantly more correct decisions when using their own applications than when using an application developed by another end user. In this study none of the end users were particularly familiar

with the problem to be solved and had the same background knowledge when using each application, so domain knowledge was not a factor. The improved performance could be due to a greater familiarity with the application itself, achieved through the development process. Successful use of user developed spreadsheet applications appears to require substantial end user knowledge because of the lack of separation of data and processing that is commonly found (Hall 1996; Ronen et al. 1989). Developing an application allows the user to develop a robust understanding of it that makes it easier to use and makes it possible for them to successfully adjust aspects of it when necessary.

The improved performance could also be due to a greater determination to achieve the correct answers, because of the higher levels of involvement. This explanation receives support from the additional time user developers spent making the decisions. On average the user developers spent an extra two and a half minutes trying to answer the 10 questions. This was unexpected, but may be due to the end user developers greater commitment to succeeding with their own applications.

McGill et al (1998) questioned the usefulness of user satisfaction as a measure of UDA success, finding that end users were significantly more satisfied with applications they had developed themselves than they were with applications developed by other end users. However no measures of performance were included in that study. This study suggests that the raised levels of user satisfaction and other perceptual variables were appropriate, as they were consistent with better levels of performance.

CONCLUSION

In conclusion, this study suggests that the process of developing an application leads to significant advantages for the end user developer. In the past, the proposed benefits of user development of applications have been mainly attributed to a belief that the user has a superior understanding of the problem to be solved by the application system (Amoroso 1988). In this study all end users encountered the problem for the first time during the experimental session so should have had equal knowledge and understanding of the problem. The relative success of the end user developers when using their own applications in this study may flow from their superior knowledge of their own applications, thus confirming one of the proposed advantages of user involvement in organisational information systems development. The advantage of superior knowledge of the application is likely to be particularly important with spreadsheet applications where data and processing are usually integrated (Hall 1996; Ronen et al. 1989). Future research should investigate whether these findings also hold when other application development tools are used and with other groups of end user developers.

There have been concerns expressed in the literature about user development of applications as an inefficient use of personnel time, distracting end users from what they are supposed to be doing (Alavi & Weiss 1985-1986; Davis & Srinivasan 1988). However, this study suggests that the potential risk of inefficient use of personnel time may be compensated for by superior decision making later, based upon insights gained from system development.

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