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Chapter XIII

End–User Perceptions of the Benefits and Risks of End–User Web Development

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ABSTRACT

The development of applications by end users has become an integral part of organizational information provision. It has been established that there are both benefits and risks associated with end-user development, particularly in the areas of spreadsheets and databases. Web development tools are enabling a new kind of end-user development. The fact that Web page creation may impact, not only locally but also globally, significantly raises the importance of this type of end-user application development. This article reports on the extent of Web page development amongst end users and investigates their perceptions of the benefits and risks of end-user Web development relative to those associated with spreadsheet development and explores approaches to reducing the risks.

INTRODUCTION

End-user computing now dominates organizational use of information technology worldwide. Its growth has been driven by increasingly inexpensive hardware, increasingly powerful and easy to use software, and user demand for control of information resources (McLean, Kappelman & Thompson, 1993; Shayo, Guthrie & Igbaria, 1999). Organizations also rely heavily on applications developed by end users. These applications support a wide range of information provision and decision making activities and contribute to business processing in a wide range of tasks (Rittenberg, Senn & Bariff, 1990). Increasingly, the ability to develop small applications forms part of the job requirements for many positions (Jawahar & Elango, 2001). The study reported on in this article explores the expansion end-user

developers are experiencing as they add the role of Web page developer to their repertoire of end-user development skills, and investigates end-user perceptions of the benefits and risks of end-user Web development relative to those of end-user spreadsheet development.

Although a wide range of tools is available for use by end-user developers, the most commonly used software tools have been spreadsheets (Rittenberg et al., 1990). The majority (88%) of the 34 organizations participating in Taylor, Moynihan, and Wood-Harper's (1998) study used spreadsheets for end-user development whereas only 35% used query languages and 12% used databases. Recently Web development tools have started to be used by end-user developers (Govindarajulu, 2003; Nelson & Todd, 1999; O'Brien, 2002; Ouellette, 1999), and it is anticipated that this use will increase rapidly in years to come (Goupil, 2000). Very little is known, however, about how end users acquire the skills necessary for successful development or about how and why they develop Web applications.

A substantial body of research has investigated the benefits and risks of development by end users and explored the factors that influence them (e.g., Alavi & Weiss, 1985-1986; Amoroso & Cheney, 1992; Benson, 1983; Brancheau & Brown, 1993; Davis, 1988; O'Donnell & March, 1987; Rivard & Huff, 1984, 1985). The benefits that have been claimed include improved decision making, improved productivity, and increased satisfaction of end users (Amoroso & Cheney, 1992). The risks that have been identified include mismatches between tools and applications (Alavi & Weiss, 1985-1986; Davis, 1988; O'Donnell & March, 1987), lack of testing (Alavi & Weiss, 1985-1986; Davis, 1988; O'Donnell & March, 1987), inability to identify correct and complete information requirements (Davis, 1988) and failure to back up data (Benson, 1983). The proposed benefits of user development of applications can be attributed to users having a better understanding of the

problem to be solved by the application, and the proposed risks to users having less understanding of the process of system development than do information technology professionals.

While problems with traditional end-user developed applications can have a large impact on organizational decision making, it has largely been believed that the possible negative impacts are limited to local effects, for example, workgroup or department (Nelson & Todd, 1999). Web development tools, however, are now enabling end users to develop applications that are accessible to vast numbers of people from all over the world (Nelson & Todd, 1999). This brings with it greater potential benefits and risks. These benefits and risks may affect business processes, customers, suppliers, and other organizations more than ever before. The study reported on in this article considers end-user perceptions of both the benefits and risks of end-user Web development and compares them to their perceptions of the benefits and risks of end-user spreadsheet development. This comparison will provide insight into areas where end-user developers are gaining new advantages due to their Web development practices, and into areas of risk that may require future attention from those responsible for end-user Web development.

Strategies for reducing the risks associated with end-user development have been presented in the literature and there is some evidence to suggest that employing them is effective. For example, Alavi, Nelson, and Weiss (1987-1988) presented a comprehensive framework of controls for addressing risks at different stages of the application life cycle, and several studies have demonstrated the value of introducing controls during the design and development of spreadsheets (Alavi, Phillips & Freedman, 1990; Janvrin & Morrison, 2000). End-user training has also been shown to positively influence attitudes to technology (Igbaria, Guimaraes & Davis, 1995; Simmers & Anandarajan, 2001) and to improve

the quality of end-user developed applications (Kreie, Cronan, Pendley & Renwick, 2000; Kruck, Maher & Barkhi, 2003).

However, despite this evidence, organizations have done little to address the risks of end-user development (Panko & Halverson, 1996; Taylor et al., 1998). Nelson and Todd (1999) investigated what strategies organizations are using to reduce the risks of end-user development on the Web. They followed up on 18 risk reduction activities identified by Alavi, Nelson, and Weiss (1987-1988). Each of these activities was classified as being in one of three categories: standards setting, resource allocation, or management and support of application development. They found that organizations placed most emphasis on setting standards, followed by resource allocation, and that support of development was the least used type of approach. They also noted that there were large gaps between the perceived importance of some approaches to reducing the risks of end-user Web development and the degree to which they were currently being used.

RESEARCH AIMS

Despite the various largely anecdotal reports of the popularity of end-user Web development (e.g., O'Brien, 2002; Ouellette, 1999), there has been little empirical research on end-user Web development. In a recent survey of end-user development, Govindarajulu (2003) found that approximately 40% of his sample of end-user developers had created static Web pages and 25% had created dynamic Web pages; however, information about the levels of experience of these end-user Web developers or the training they had received was not available. Given the potential importance of end-user Web development, more needs to be known about end-user Web developers and the preparation they receive. The first two aims of this study were therefore to:

1. Explore the extent of end-user Web development among current end-user developers
2. Explore the training end users receive to prepare them to undertake end-user Web development

As discussed, Web development tools facilitate the development of applications that are more widely accessible than end-user developed applications have traditionally been (Nelson & Todd, 1999). End-user Web development has the potential to bring greater benefits to end users and their organizations, but also has the potential for increasing risks. The benefits and risks of end-user Web development may affect the various stakeholders more than ever before. As spreadsheet development has been the most common form of end-user development to date, the benefits and risks of Web development relative to spreadsheet development are of interest. The next aim of the study was therefore to:

3. Compare end-user developers' perceptions of the relative benefits and risks of end-user spreadsheet development and end-user Web development

Despite research highlighting the risks of end-user development, organizations have done little to counter them (Panko & Halverson, 1996; Taylor et al., 1998). Given the potential for greater risks to be associated with end-user Web development, more research is required on approaches to addressing these risks. The only significant research to date on the risks of end-user Web development is the study by Nelson and Todd (1999) that surveyed predominantly information technology staff (28 out of 34) with the remainder being senior management. Given that end users themselves have a large degree of control over the success or otherwise of their applications, there is also a need to consider end users' perceptions of the various approaches to reducing risks. The final aim of this study was therefore to:

4. Investigate the perceptions of end-user developers as to the importance of various approaches to reducing the risks of end-user Web development

THE PROJECT

This study was conducted via survey. The participants were a group of end users who were known to have developed spreadsheet applications, but whose experience with Web development was unknown. This group was targeted as it provided an opportunity to explore the uptake of end-user Web development among experienced end-user developers, and also to compare perceptions of the benefits and risks of the two types of development.

Participants

The sample for this study consists of 60 end-user developers who had previously participated in a study on end-user spreadsheet development. The participants in the previous study were active end-user developers from a wide range of business organizations. They had a wide range of experience and training (details of the original study can be found in McGill, 2004). Thirty-five percent of the participants in the current study were males, and 65% were females. Ages ranged from 20 to 67 years with an average of 45 years.

Procedure

A summary of the results of the earlier spreadsheet study was mailed to all participants, along with a request to participate in the current study by completing an enclosed questionnaire. Some participants, for whom no postal address details were recorded, were initially contacted via e-mail and asked to participate in the current study before being mailed the questionnaire. Those who failed to return the questionnaire and for whom e-mail

addresses were recorded were sent a reminder by e-mail after approximately three weeks. One hundred and sixty-seven questionnaires were mailed out and 60 completed questionnaires were received, giving a response rate of 36%.

The Questionnaire

The questionnaire consisted of several sections. The first section asked questions about the background and previous computing experience of participants. The second section asked specifically about Web page development experience and training, and where relevant, explored reasons for nondevelopment. The third and fourth sections included questions to be answered by all respondents about the potential benefits and risks of both spreadsheet development and Web page development. The final section addressed approaches to reducing the risks of end-user Web development. The draft questionnaire was pilot tested by four end users and slight changes made to clarify the questions.

Section 1: Background Information

The first section asked questions about the participants and their previous training and experience with computers, spreadsheets, and the Internet. Experience was measured in years. Questions relating to spreadsheet and Internet training asked about formal courses and self study separately using measures that were adapted from Igbaria (1990) and are similar to those used by Simmers and Anandarajan (2001) in their study of Internet user satisfaction in the workplace. The items had a 5-point scale where (1) was labelled "none" and (5) was labelled "very intensive."

Section 2: Web Development Experience

Levels of Web development training were also obtained for formal courses and self study separately,

using items similar to those described earlier in this section. In order to determine which Web development tools end users had used, a list of nine popular tools (see Table 4) was created based on information from a review of authoring tools (Moore, 2002). Respondents were asked whether they had used each of them and also given provision to name any other tools used. Reasons for nondevelopment were explored via three items that were developed for this study. Respondents were asked to rate the importance of each reason for nondevelopment on a 5-point scale where (1) was labelled “not important” and (5) was labelled “very important” (see Table 5 for the items).

Sections 3 and 4: Benefits and Risks

A list of the major benefits and a list of the major risks were developed from the literature on benefits and risks of development by end users (Alavi & Weiss, 1985-1986; Amoroso & Cheney, 1992; Benson, 1983; Brancheau & Brown, 1993; Davis, 1988; O’Donnell & March, 1987; Rivard & Huff, 1984, 1985). Each potential benefit and risk was rated for importance on a 5-point scale measured from (1) “not important” to (5) “very important.” Twelve questions addressed potential benefits and 12 questions addressed potential risks (see Table 6 and Table 7 respectively for lists of the potential benefits and risks).

Section 5: Approaches to Reducing the Risks of End-user Web Development

The questionnaire included 14 items to measure the perceived importance of the major activities that can be undertaken to reduce the risks of end-user development on the Web. These items are from the Nelson and Todd (1999) instrument. Each approach was rated for importance on a 5-point scale measured from (1) “not important” to (5) “very important.”

RESULTS AND DISCUSSION

Spreadsheet, Internet, and Web Development Experience

Table 1 summarizes how long the respondents had been using computers, spreadsheets, and the Internet. On average, they had been using computers for 14 years (ranging from 4 years to 30 years). Some participants had considerable experience, as 30 years of use indicates adoption very early in the personal computing revolution. The average length of spreadsheet use was just under 8 years (with a range of a few months through to 21 years). Respondents had been using the Internet for an average of around 6 years (ranging from not having used it at all to 12 years). Considering

Table 1. Background characteristics of respondents

	Mean	Minimum	Maximum	Standard Deviation
Age (years)	44.68	20	67	10.32
Computing experience (years)	14.22	4	30	6.66
Spreadsheet experience (years)	7.85	0	21	5.40
Internet experience (years)	6.19	0	12	2.79

End-User Perceptions of the Benefits and Risks of End-User Web Development

the WWW came into practical existence around 1994, some of the respondents were obviously at the forefront of online communications, having used the Internet prior to the emergence of the WWW. However, most respondents appear to have used the Internet for between 3 and 9 years, indicating Internet use as being dependent upon the emergence of the WWW. Internet use appears to have coincided largely with spreadsheet use, with respondents having used spreadsheets for only about a year and a half longer on average than they have been using the Internet.

Reasons for spreadsheet and Internet use were also investigated and the results are reported in Table 2. Ninety percent of the respondents used

spreadsheets for work purposes and 73% used them at home. The Internet was used even more heavily for both work and personal tasks (91.7% and 93.3% respectively). It is worth noting that of the 60 respondents, only 1 reported not having used the Internet at all. These figures suggest a rapid increase in Internet usage in the workplace. In an Internet demographics survey in 1998, only 50% of Internet users were found to use the Internet at work (Commercenet, 1999).

Web page development was not as common. Just under half (27 or 45%) of the total sample of 60 spreadsheet end-user developers surveyed had engaged in Web page development. Of these 27 end users, 55.5% (15 people) had created

Table 2. Reasons for use

	Number	Percentage*
<i>Spreadsheet</i>		
Work purposes	54	90.0
Personal purposes	44	73.4
<i>Internet</i>		
Work purposes	55	91.7
Personal purposes	56	93.3
<i>Web page development</i>		
Any Web page development	27	45.0
Work purposes	15	25.0
Personal purposes	18	30.0

* Of total sample of 60 respondents

Table 3. Levels of previous training

	Number	Mean	Minimum	Maximum	Standard Deviation
<i>Spreadsheet</i>					
Formal	60	1.98	1	5	1.05
Self study	59	2.69	1	5	1.21
<i>Internet</i>					
Formal	60	1.63	1	4	0.80
Self study	59	2.61	1	5	1.08
<i>Web development</i>					
Formal	27	1.96	1	4	0.98
Self study	26	2.58	1	5	1.03

Table 4. Web development tools used

	Number	Percentage
Microsoft Frontpage	15	55.6
Microsoft Word	13	48.1
Notepad	12	46.2
Macromedia Dreamweaver	11	40.7
HotDog Pro	2	7.4
Adobe GoLive	1	3.7
Macromedia Homesite	1	3.7
CoffeeCup HTML Editor	1	3.7
HotMetal Pro	0	0.0

Web pages for work use and 66.7% (18 people) had done so for personal interests. It would be useful to further explore the nature of the Web development that the participants had undertaken. Simmer and Anandarajan's (2001) index of Web page experience would provide a starting point for future research on the nature of development undertaken.

Previous Training

Respondents had had little formal training in spreadsheets, Internet use, or Web page development. The average level of formal spreadsheet training was 1.98 (out of 5) and the average level of self study training was 2.69, so self study was the main source of spreadsheet training. This is consistent with previous research on spreadsheet users, which has reported that spreadsheet users generally receive little training (Taylor et al., 1998) and that the major means of training is self study (Chan & Storey, 1996; Hall, 1996).

The average level of formal Internet training was 1.63, and the average level of self study training was 2.61, so self study was again the main source of training. This is consistent with the findings of Simmer and Anandarajan (2001) in their study of Internet use in the workplace; however, it is

unclear whether the relatively high level of self training is because end-user developers prefer self training or because other forms of training are not available. Over half (55%) had received no formal training and almost half (47%) indicated that they had either not undertaken any self study or had done very little. No respondents rated their formal Internet training as extremely intensive and only two (3.3%) rated their self study as extremely intensive.

Those respondents who had developed Web pages were asked to indicate their prior Web page development training. As can be seen from Table 3, levels of Web development training were relatively low but consistent with levels of spreadsheet training, with an average of 1.96 out of 5 for formal training and 2.58 out of 5 for self study. Self study was again the predominant method of training. Forty percent of those who had developed Web pages had received no formal training. Again, the emphasis on self training is consistent with other forms of end-user development such as spreadsheet development (Chan & Storey, 1996; Hall, 1996), but may also indicate the "fun" aspect of engaging in what is currently seen as "hot" (Atkinson & Kydd, 1997). The role of self training in end-user Web page development should be investigated in further research.

Table 5. Reasons for not developing Web pages

	Mean	Minimum	Maximum	Standard Deviation
No professional need (/5)	1.45	1	5	1.00
No personal need (/5)	1.58	1	4	0.89
Would like to, but do not know how (/5)	2.50	1	5	1.42

Table 6. Perceived importance of benefits

Benefits	Web Development		Spreadsheet Development		Sign.
	Mean Impt.	SD	Mean Impt.	SD	
Improved accessibility of information	4.25	1.07	4.27	0.96	0.922
Improved communication of information	4.12	1.08	4.05	1.02	0.759
Faster response to information requests	3.82	1.15	4.00	1.06	0.216
Direct control over information and applications	3.66	1.28	3.77	1.27	0.153
Better use of limited resources	3.54	1.24	3.62	1.08	0.262
Improved user computer literacy	3.30	1.25	3.07	1.31	0.151
Encourages experimentation and innovation	3.27	1.10	3.18	1.32	0.910
Reduction in development backlog	3.20	1.24	3.10	1.41	0.825
Increased user satisfaction	3.18	1.10	3.31	1.28	0.345
Improved productivity	3.12	1.31	3.97	0.94	<0.001***
Improved decision making effectiveness	3.02	1.26	3.90	1.12	<0.001***
Improved relationships with IT staff	2.46	1.19	2.55	1.94	0.416

It appears that a substantial proportion of Internet and Web development learning may be achieved via activities and interactions that are not perceived as training. This reinforces the popular image that “people enjoy surfing the Web” (Atkinson & Kydd, 1997) and raises the issue of the role of communities of practice, where learning occurs by end-user developers doing and sharing with their peers (Stamps, 2000). The role of communities of practice in end-user Web development should be explored in future research.

Web Development Tools Used

As can be seen in Table 4, the most common tool used by the 27 respondents who had developed Web pages was Microsoft FrontPage (55.6%).

This is consistent with the case study discussed in Ouellette (1999), where Microsoft Frontpage was used by 108 end users who contribute to an intranet. The second most commonly used tool was Microsoft Word (48.1%). The third most frequently used tool was Notepad (46.2%), which suggests some measure of familiarity with HTML code, and may indicate a desire on the part of users to “understand” and have more control over Web page development, not just create the pages. The final tool of significance is Macromedia Dreamweaver, which had been used by 40.7% of users. As Dreamweaver is a rather expensive program for home use, perhaps it would be fair to say that this tool was primarily used in the workplace. No other tools were used by more than two respondents.

Nondevelopment

The reasons why almost one half of the sample of spreadsheet developers had not yet developed Web pages were also explored. Thirty-three respondents (55.0%) reported not having created a Web page and their reasons are listed in Table 5. The most important reason for not creating Web pages was lack of knowledge despite wishing to do so (with an average importance of 2.50 out of 5), while lack of professional need and lack of personal need were rated as less important on average (1.45 and 1.58 respectively out of 5). It is worth noting that not one person strongly disagreed with “no personal need for creating a Web page,” indicating a recognition of the role that Web page development plays in many people’s personal lives and possibly acknowledging the potential for it to enter their own. This subset of respondents was also asked if they anticipated developing Web pages in the future. Eleven people (33%) indicated that they did not anticipate developing Web pages in the future, 5 (15%) indicated that they would create a Web page in the future, while 19 (58%) acknowledged the possibility of doing so. As it is very difficult to predict future needs, the high percentage in the “possibly” category reflects acceptance of the rate of change that is associated with the Internet (Burn & Loch, 2001).

Benefits of End-User Web Page Development and Spreadsheet Development

Table 6 presents the average perceived importance of each potential benefit for both Web development and spreadsheet development. The ratings of benefits are ranked by perceived importance for Web page development. The average importance of each potential benefit was compared between Web development and spreadsheet development using paired t-tests and the results are also reported in Table 6.

The most important perceived benefits of Web development relate to accessing and disseminating information. Improved accessibility of information was ranked most highly and was followed closely by improved communication of information. Faster response to information requests and direct control over information and applications were ranked third and fourth respectively. End users recognize that Web page development gives them a unique opportunity to both provide and access information. While increasing access to the Internet and the availability of user-friendly browsers has made accessing sites developed by information technology professionals a valuable information gathering approach, the development of user-friendly Web development tools has enabled end users to participate in information dissemination to a degree never before possible. These first four benefits were also rated highly as benefits of spreadsheet development, and no significant differences were found between their importance for Web development and their importance for spreadsheet development. Presumably Web development allows access to, and dissemination of, information over a wider domain, but spreadsheet development allows more focused specific addressing of information needs.

The middle ranked benefits appear to reflect personal benefits from end-user development. Better use of limited resources was ranked fifth followed by improved user computer literacy and encouragement of experimentation and innovation. End-user developers appear to place moderate value on what they learn and gain from development beyond their specific task oriented information needs. These results for end-user Web development are consistent with the literature on other kinds of end-user computing (Agarwal, 2000; Amoroso & Cheney, 1992; Davis, 1988; Pentland, 1989) and no significant differences were found between perceptions of their importance as benefits of Web development and spreadsheet development.

Table 7. Comparison of risks

Risks	Web Development		Spreadsheet Development		Sign.
	Mean Impt.	SD	Mean Impt.	SD	
Unreliable systems	4.24	1.03	3.61	1.21	<0.001***
Lack of data security	4.19	1.10	3.84	1.36	0.057 ^m
Incompatible end-user tools preventing sharing of applications and information	4.19	0.93	3.93	1.14	0.332
Inability to identify correct and complete information requirements	4.00	1.08	4.02	0.94	0.371
Lack of testing	3.96	1.04	3.77	1.13	0.455
Lack of documentation for applications	3.93	1.11	3.86	1.16	0.672
Mismatch between development tools and applications	3.87	1.10	3.68	1.18	0.667
Use of private systems when organizational systems would be more appropriate	3.83	1.10	3.60	1.12	0.411
Failure to back up data	3.81	1.16	4.16	1.15	<0.001***
Inefficient use of personnel time	3.79	1.04	3.44	1.16	0.225
Solving the wrong problem	3.51	1.28	3.68	1.09	0.044*
Redundant development effort	3.41	1.17	3.70	1.08	0.014*

*** < 0.01; * < 0.05; ^m < 0.1

Reduction in development backlog was ranked fairly lowly at eighth in importance among the Web development potential benefits. This implies that end users are not developing applications that would otherwise be developed by information technology professionals. Their Web pages are in addition to those deemed necessary by their organizations and hence their development effort may not impact significantly on development backlogs. This is consistent with the perception of reduction of development backlog as a benefit of spreadsheet development as no significant difference was found between the ratings.

The ninth most important perceived benefit of end-user development was user satisfaction and its relatively low ranking suggests that while Web development tools have become more user-friendly, Web development is not yet a straightforward and satisfying experience. End users perceived the experience as one of learning and self-improvement rather than one that satisfies or results in

applications that improve user satisfaction. The user satisfaction resulting from spreadsheet development was not significantly different from that resulting from Web development, suggesting that spreadsheet development is also not yet a straightforward and satisfying experience.

The tenth and eleventh ranked benefits of Web page development were improved productivity and improved decision making effectiveness. Thus, Web page development was not perceived as a particularly important source of productivity or decision making effectiveness. Web page development leads to information dissemination for the developer, but the participants in this study did not see this as improving their own productivity or decision making effectiveness, nor that accessing information provided from Web pages developed by other end users would play an important role in improving their own productivity. This raises questions about the purposes of user developed Web pages. Future research should explore more

closely the reasons for which Web pages are developed by end users. Spreadsheet development was considered to be a significantly more important source of productivity benefits ($t(55) = 4.97, p < 0.001$) and of benefits resulting from improved decision making ($t(55) = 6.46, p < 0.001$).

The lowest ranked potential benefit for both Web development and spreadsheet development was improved relationships with information technology staff. The low ranking reinforces the idea that end-user Web development is an activity that is removed from organizational system development. End users do not perceive it as supporting organizational development. The low ranking may possibly reflect the introduction of additional tensions in relationships with information technology staff, brought about by the risks of end-user development.

No significant differences were found in the importance ratings of any benefits between those who had and those who had not previously developed Web pages.

Potential Risks

Table 7 presents the average perceived importance of each potential risk for both Web development and spreadsheet development. The ratings of risks are ranked by perceived importance for Web page development. The average importance of each potential risk was compared between Web development and spreadsheet development using paired t-tests.

All potential risks of Web development were rated fairly highly with averages above the midpoint of the scale, which implies a good awareness of the problems that can plague end-user development. Unreliable systems were perceived as the most important risk, with lack of data security ranked closely behind. The potential for development of unreliable and insecure systems has long been recognized as one of the major problems with end-user development (Benson, 1983; Brancheau & Brown, 1993). Despite this

recognition, organizations have done little to protect against it (Panko & Halverson, 1996). The high ranking of this risk with respect to end-user Web development reflects the increased level of importance of the problem due to the global accessibility of Web-based systems. The potential for damage to the reputation of an organization has increased as applications have become accessible by vast numbers of people from all over the world (Nelson & Todd, 1999). Unreliable systems was perceived to be a significantly less important risk for spreadsheet development ($t(53) = -3.60, p = 0.001$) and lack of data security was also rated a less important risk for spreadsheet development ($t(53) = -1.95, p = 0.057$). This suggests that end-user developers are very aware of the increases in risk associated with Web development.

Incompatible end-user tools preventing sharing was ranked equal second in terms of importance as a risk of Web development. The last decade has been marked by great improvements in the compatibility of end-user software; hence this result was unanticipated and requires further research.

The midranked group of risks all focus on the ability of the end-user developer to undertake specific necessary development tasks such as identifying requirements, testing, documenting, and choosing appropriate development tools. The respondents appeared to recognize the importance of each of the activities and the risks that can result from lack of skills in these areas. No significant differences were found between the perceived importance of these risks between Web development and spreadsheet development.

Use of private systems when organizational systems would be more appropriate was ranked the eighth most important risk of Web development, and failure to back up data as the ninth. Both of these risks normally relate to use of user developed Web applications rather than the actual development process and their lower ranking suggests that the respondents recognize that the major risks result from development practices

rather than from use of applications. Failure to back up data was rated as significantly less important a risk for Web development than for spreadsheet development ($t(52) = 4.43, p < 0.001$). In fact, failure to back up data was perceived as the most important of all the potential risks of spreadsheet development. This may be because the types of Web applications developed by end users are likely to involve static data, whereas the data in end-user developed spreadsheet applications is likely to be updated more often, and hence is more vulnerable and reliant on regular backup in case of problems. Further research on the types of Web applications developed by end users is required to understand the perceptions of these risks.

The lowest ranked risks of Web development were inefficient use of personnel time, followed by solving the wrong problem and lastly redundant development effort. However, none of these risks was discounted, with averages that indicate that the majority of respondents recognized them as risks of relative importance. Not one respondent rated inefficient use of personnel time as “not important”; 5 (9.4%) rated solving the wrong problem as “not important,” and 1 (1.9%) rated redundant development effort as “not important.” The participants considered solving the wrong problem and redundant development effort to be greater risks when undertaking spreadsheet development ($t(52) = 2.06, p = 0.044$; $t(52) = 2.55, p = 0.014$). This may reflect an increased sophistication of end-user developed spreadsheet applications compared to end-user developed Web applications.

It was interesting to note that the average importance of each risk was lower for the group who had previously developed Web pages than for the group who had not, although the differences were only significant for four risks (inability to identify correct and complete requirements ($t(52) = 2.36, p = 0.022$), use of private systems when organizational systems would be more appropriate ($t(52) = 2.19, p = 0.033$), solving the wrong problem

($t(51) = 2.54, p = 0.014$), and redundant development effort ($t(52) = 2.70, p = 0.009$)). A reason for this difference could be that the development process has given them insight that allows them to discount the risks; however this seems unlikely given the prevalence of problems with end-user developed applications. It would seem more likely that the satisfaction they derive from their own Web development allows an overshadowing of the perceptions of risks. This should be explored further in future studies.

Future research should also differentiate between different types of Web applications that might have different risks and benefits. For example, the risks associated with end-user developed Web pages that merely display information could be considered substantially less than those associated with applications that process information.

Approaches to Reducing the Risks of End-User Web Development

The approaches to reducing the risks of end-user Web page development are ranked by perceived importance in Table 8, which also includes the average importance of each of the approaches reported for the predominantly information technology staff in the Nelson and Todd (1999) study. The importance of each approach as perceived by the end-user developers in the current study is compared with the average obtained in Nelson and Todd's study using one sample t-tests and the results are also presented in Table 8. All of the approaches were rated fairly high by the end-user developers with averages above the midpoint of the scale. The highest ranked approach was training. As discussed earlier, previous studies have found that end-user developers receive very little training and what they do get tends to be self-training rather than formal training (Chan & Storey, 1996; Hall, 1996). The results in this study regarding training for Web development are consistent with other forms of end-user development such as

End-User Perceptions of the Benefits and Risks of End-User Web Development

Table 8. Approaches to reducing the risks of end-user Web development

Rank	Approaches to Reducing the Risks of End-User Web Page Development	This Study		N & T Study Mean	Sign.
		Mean	SD		
1	Training	4.39	0.81	3.48	<0.001***
2	Policies on data management	4.39	0.71	4.25	0.157
3	Coordination across organizational boundaries	4.31	0.75	4.00	0.003***
4	Assignment of roles and responsibilities	4.28	0.81	3.61	<0.001***
5	Standards for purchases of hardware and software	4.19	0.83	3.76	<0.001***
6	Data access	4.17	0.86	3.85	0.009***
7	Planning for equipment, capacity, and manpower	4.17	0.77	3.97	0.066 ^m
8	Scope of Web-related activities	4.15	1.02	3.03	<0.001***
9	Systems integration	4.11	0.86	3.36	<0.001***
10	Consulting	4.06	0.90	3.58	<0.001***
11	Audit and review	3.98	1.04	3.47	0.001***
12	Standards for end-user development	3.98	0.84	3.73	0.031*
13	Setting priorities	3.89	0.90	3.88	0.943
14	Documentation	3.83	1.00	3.18	<0.001***

*** < 0.01; * < 0.05; ^m < 0.1

spreadsheet development. The acknowledgment of the importance of training is quite interesting; despite having received little training themselves, the respondents considered training to be the most important approach to reducing the risks of end-user Web development. Nelson (1991) suggested that training is perhaps the most effective tool for minimizing the risks associated with end-user development and the results of this study suggest that end users agree.

Policies for data management were considered to be the second most important approach. This was unexpected because end-user developers have traditionally been dissatisfied with approaches to the management of end-user computing that involved control rather than support (Bergeron & Berube, 1988; Bowman, 1988). However, this ranking is promising as it suggests that end-user Web developers recognize that Internet applications are particularly vulnerable to data

security risks and that therefore these must be addressed.

The middle grouping consisted of a number of approaches of similar importance that include assignment of roles and responsibilities, standards for purchases of hardware and software, and scope of Web-related activities (i.e., clear distinctions between applications that are developed by end users and by information technology professionals) among others. The very consistent levels of importance given to these suggest that end users recognize that a variety of approaches is necessary, all of which are complementary.

Audit and review standards for end-user development and a requirement for documentation of Web applications were ranked towards the bottom of the possible approaches. This is consistent with previous research that suggests that users are less satisfied when subject to greater application development control (Bergeron & Berube, 1988;

Bowman, 1988). Nevertheless, a need for setting and enforcing organizational development standards for end users has been widely recognized (Cragg & King, 1993; Guimaraes, Gupta & Rainer, 1999). Setting priorities was also not given a high importance ranking. This suggests that, as might be expected, end-user developers consider the Web development they do as an individual activity designed to support their own work rather than part of an organizational information technology strategy.

As can be seen in Table 8, the end-user developers who responded to this survey rated every approach to reducing the risks of end-user Web development more highly than did the information technology professionals and senior management who participated in Nelson and Todd's (1999) study. These differences were significant for all except two of the approaches (policies on data management and setting priorities). The approaches on which opinion differed the most were training ($t(53) = 8.24, p < 0.001$) and scope of Web-related activities ($t(53) = 8.08, p < 0.001$). Information technology staff involved in managing end-user development should recognize the importance to end users of appropriate training to support their development activities and of the need for clear distinctions to be made to enable the confidence of end users in determining which projects are appropriate for them.

There have been previous calls for increased provision of training to Internet users (Aggarwal, 2003). The results of this study reinforce the importance of this. However, given the relative prevalence of self training in end-user Web development training, the role of self training should be further explored. It has been suggested that, when end users are self taught, the emphasis is predominantly on how to use software rather than broader analysis and design considerations (Benham, Delaney, & Luzzi, 1993). The many books that cover introductory Web development typically give a detailed step-by-step coverage of examples that illustrate product features. Ex-

amples are presented as solutions to requirements without the design stages being made explicit. Thus end users may have a narrow knowledge focused on software features but lacking in techniques for developing Web applications that are user-friendly, reliable, and maintainable. Taylor, Moynihan and Wood-Harper (1998) found that few, if any, quality principles are applied in end-user development. Therefore, organizations that rely on self training must ensure that end users have materials available that will help provide all of the skills necessary for developing good quality Web applications. This is consistent with Shaw, DeLone, and Niederman's (2002) finding that documentation to support training was perceived as one of the most important information technology support factors in terms of user satisfaction. Given the current heavy reliance on end-user developed applications and the increased risks associated with end-user development in the Internet domain, it is essential that organizations support end users as they strive to become proficient Web developers.

Guidelines on the kinds of applications that are suitable for end-user Web development should also be provided (Goupil, 2000). Several authors have proposed guidelines recommending what kinds of applications are appropriate for end-user development (Salchenberger, 1993), and what kinds are not (Bowman, 1990). These types of guidelines need to be researched further so that more detailed assistance can be provided to prospective end-user developers. In particular, the ability to tailor recommendations on what types of applications are appropriate to individual end users' backgrounds would be very valuable. Given the current heavy reliance on end-user developed applications and the increased risks associated with end-user development in the Internet domain, it is essential that organizations support end users as they strive to become proficient Web developers.

As discussed in the Introduction, each of the approaches to risk reduction was classified as relating to standards setting, resource allocation,

or management and support of application development (Nelson & Todd, 1999). Nelson and Todd (1999) found that organizations in their study placed most emphasis on setting standards, followed by resource allocation, and that support of development was the least used type of approach. They noted that most firms in their study appeared to be relying on a monopolistic control strategy (as described by Gerrity and Rockart, 1986, and Alavi et al., 1987-1988) and then concluded that while such a strategy may be the best approach given the relative infancy of Web technology, it could prove to be an unstable strategy in the future. The results of the study reported in this article suggest that end-user developers would support a change to the strategies used to manage end-user Web development with greater emphasis placed on support of development via such mechanisms as training and clear definition of roles and responsibilities.

Those who had and those who had not previously developed Web pages were compared with respect to their perceptions of the importance of the approaches to reducing the risks of Web

development. As with perceptions of risks, those who had previously developed Web pages tended to rate the importance of the approaches lower than did the end users who had not, although the differences were only significant for two approaches: standards for purchases of hardware and software activities ($t(52) = 2.80, p = 0.007$) and scope of Web-related activities ($t(52) = 2.22, p = 0.031$).

Main End-User Web Development Issues

The study reported on in this article explored the nature of the emerging area of end-user Web development. A range of areas were investigated and Table 9 below summarizes some of the main issues that emerged. The study highlighted that Web development is becoming popular among end users both as part of work responsibilities and in pursuing personal interests. This popularity is likely to increase. Yet, consistent with other kinds of end-user development, end users receive little formal training to prepare them for it. The

Table 9. Summary of main issues

Issue	The study found ...
Extent of Web development	Over half of the spreadsheet developers surveyed also develop Web pages.
End users receive little formal training	40% of end users who had developed Web pages had received no formal training.
End users consider training to be the most important strategy for reducing the risks of end-user Web development	The average importance rating for training was 4.39 (out of 5).
End users have a good awareness of the risks of end-user Web development	All potential risks of Web development had averages above the midpoint of the scale (i.e., were considered important).
End users recognize the need for complementary approaches to risk reduction	All strategies for risk reduction had averages above the midpoint of the scale (i.e., were considered important).
End users appear to be becoming more sophisticated in matching tools to applications	Web development was rated very highly for improving accessibility of information, but was significantly less important than spreadsheets for improving decision making effectiveness.

end users surveyed recognized the importance of training and considered it to be the most important strategy for reducing the risks associated with end-user development of Web applications. This finding was not however mirrored in the Nelson and Todd (1999) study. The information technology staff in that study considered training to be one of the less important strategies. Given the potential impacts of end-user developed Web applications, organizations increase the risks by not adequately preparing end users.

The end users surveyed showed a good awareness of the risks of end-user Web development. All potential risks of Web development were rated fairly high with averages above the midpoint of the scale, which implies a good awareness of the problems that can plague end-user development. It is reassuring that end users do not discount the risks. This is also reflected in their recognition of the need for complementary approaches to risk reduction.

There has been concern expressed in the literature about the ability of end users to recognize what kinds of development tools are appropriate for different sorts of applications (Alavi & Weiss, 1985-1986; Davis, 1988; O'Donnell & March, 1987). The comparative rankings of the perceived benefits of Web development and spreadsheet development suggest that end users are becoming more sophisticated in matching tools to applications. For example, Web development was rated very highly for improving accessibility of information, but significantly less important than spreadsheets for improving decision making effectiveness.

CONCLUSION

Despite early concerns about its risks (e.g., Alavi & Weiss, 1985-1986; Davis, 1988), end-user development has become an integral part of organizational information provision (McLean et al., 1993; Shayo et al., 1999). End-user developers

may now take advantage of user-friendly Web development tools to create Web applications and the prevalence of these applications will only increase (Ouellette, 1999). The study reported on in this article investigated the extent of Web page development among end users and compared end-user perceptions of the benefits and risks of end-user Web development with their perceptions of those associated with spreadsheet development. Almost half of the sample of spreadsheet users studied had created Web pages, yet they had received little prior training in Web development. Microsoft Frontpage was the most common tool used for Web development; however almost half had previously used Notepad indicating some familiarity with HTML code. This suggests a desire to "understand" and have more control over Web page development. The most important reason for not creating Web pages was lack of knowledge, and the majority of those who had not yet created Web pages acknowledged the possibility of doing so in the near future.

As can be seen from the discussion of the risks and benefits of end-user development, although end-user Web page development has many characteristics in common with traditional end-user development, there are many areas in which Web page development differs and it is important that research into these areas continues. It seems that end-user Web development is here to stay and will have far-reaching consequences. Management of its risks will therefore be of increasing importance to organizations. The results of this study have practical implications for the management of end-user Web development in organizations. End-user developers are aware of both the benefits and risks of end-user Web development and it will be essential to ensure their involvement in the development of approaches to control risks.

Previous research suggests that end-user developers respond better to approaches that emphasize support for development of high quality and appropriate applications rather than control of development (Bergeron & Berube, 1988;

Bowman, 1988). The results of this study support this, with training seen as the most important approach to the reduction of the risks of end-user Web development. Self training was found to be the most prevalent type of training but it is unclear from this study whether this is because end-user developers prefer self training or because other forms of training are not available. Simmers and Anandarajan (2001, p. 55) recommended that “formal training should be planned and implemented so that the positive attributes of self-training (flexibility, moving at one’s own pace, freedom and autonomy) can be blended with organizational requirements, creating a better training experience for both the individual and the organization.” This advice appears sound and meshes with the need to explore the role of communities of practice in end-user Web development.

Finally, the current study raises several potential areas for further study. As end-user Web development is likely to increase in the future, better guidelines are needed to help identify applications that are particularly suited for end users with a particular background. The different types of Web applications developed by end users carry different risks, so future studies should differentiate between types of applications in order to further clarify the associated risks. The participants of the present study identified training as one of the most significant factors in reducing the risk associated with end-user developed Web pages, yet users appear to be gaining their knowledge from self training rather than formal training. This role of self training should be further investigated. Additional studies are also needed to further examine the reasons for Web page development, as it appears that the satisfaction derived from end-user Web development may overshadow the risks associated with these applications that are accessible to vast numbers of people from all over the world.

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