Descriptive Research in End User Computing: Embracing the "D Word" to Understand End User Innovation

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ABSTRACT

Although end user computing appears to be enormously widespread and important, we do not have a detailed, data-grounded understanding of who end users are, what they do, or how they use computers to innovate. To develop that understanding, we need to do detailed descriptive research. We need to understand the ways in which corporations are structured and ways to segment the end user community into groups that are likely to have different needs and different paths to innovation. In marketing, we say that the customer is "the familiar unknown." Although businesses think about customers all the time, marketers have learned over time that they cannot understand customers unless they do broad research on them. The same need exists in end user computing research. This paper discusses statistical data on occupational employment to give a broad picture of the diversity that exists among end users. It then discusses why we must reconceptualize organizational structure before we can understand the diversity of end users. Finally, the paper discusses a research project design to develop an understanding of organizational structure and of end user issues and innovations in a professional services organization.

KEYWORDS

Descriptive research, end user computing, EUC, end user innovation, spreadsheet, knowledge workers, professional services, organizational structure.

INTRODUCTION

Dark Matter and Dark Energy

Panko and Port [14] likened end user computing to dark matter and dark energy in physics. In the 1930s, physicists realized that ordinary visible matter is dwarfed by an unseen and very different type of matter—dark matter. Although dark matter is invisible, it governs the structure of galaxies much more than ordinary matter. Near the end of the 20th century, physicists discovered the existence of *dark energy*, which is three times larger than ordinary matter and dark matter combined. While gravity is trying to force the universe to contract, dark energy is pushing the universe outward at an ever-increasing rate.

Like dark matter, end user computing has long been overlooked by corporate management, IT departments, and IS researchers. These three groups have tended to focus on central information systems and their derivatives, such as management reporting. However, Panko and Port [14] showed that there is good evidence that end user computing is much larger than central information systems and that EUC is very important to employees. Even more importantly, end user computing seems to be like dark energy in physics. New developments in end user computing seem to be spurring widespread innovation in how people work—especially among the knowledge workers that drive the corporation forward.

Although Panko and Port [14] found a considerable amount of evidence that EUC is both widespread and highly important, their data consisted of many scattered studies of many different aspects of end user computing. In addition, while they offered a broad picture of end user computing, their picture was out-of-focus and incomplete. If researchers want EUC to be taken seriously, we will need to bring this picture into much sharper focus with a wide-angle lens.

The Need for More Descriptive Research

This paper argues that an important way to improve our understanding of end user computing will be to increase the amount of exploratory descriptive research that looks directly at end users in a way that is not bound to theory. Researchers should continue to focus on more specific aspects of EUC, such as which training method for a particular purpose is more efficient. However, we also need to do research that looks at end users and begins to ask broad fundamental questions. How many end users are there? What are the different types of end users? Do different types of end users use different tools to different degrees? How do end users innovate in general, and do different types of end users innovate in different ways?

Information systems research journals do not tend to publish exploratory descriptive research extensively. We argue that this is a mistake.

- **Research Target Selection**. Doing specific theory-based research projects is like drilling a small peephole in a wall and looking through it. If the researcher drills the peephole in the wrong place, the researcher may miss critical things. Descriptive research gives the broad lay of the land so that researchers can choose specific confirmatory research targets more intelligently. In marketing, corporations do *market research* to understand the broad features and important segments of their markets before doing specific *marketing research* projects on specific topics. A great deal of end user computing research on knowledge workers has focused on central line managers. Is this really the most critical type of end user to study? We will see later that line managers constitute only a small fraction of the knowledge workforce.
- **Reducing Reliance on Theory**. Although doing descriptive research can lead to dust-dry empiricism, the danger of doing too much descriptive research does not seem to be a pressing danger in our field. In fact, being as theory-focused as the IS research field is can be a concern. In writing about research on human cognition, Anderson [1] said that the problem has been "too little data given the amount of theory." As Nobel Prize winner Alexis Carrell put it, "A few observations and much reasoning leader to error; many observations and a little reasoning to truth."
- **Need for Continuing Descriptive Research**. Descriptive research usually is especially common at the beginning of a research field. It is certainly true that there were many interesting descriptive studies done on end user computing in the 1970s and 1980s. However, although these studies generally found that end user computing would soon eclipse central IT in importance, there have not been follow-on studies to see if that actually happened. In addition, given the pace of change in technology, end users probably are reinventing what EUC means every few years. We should be doing *continuing* descriptive research to understand this ever-changing phenomenon.
- **Data Leads to Theory**. Extensive descriptive research can lead to new theory. This has certainly been the case in physics. After Tycho Brahe died, Johannes Kepler received Brahe's mass of data on stellar and planetary motions. This not only allowed him to give convincing proof of heliocentricism. It also enabled him to show that planetary orbits were not circular and allowed him to develop a correct theory of planetary motion. If we begin collecting extensive descriptive research on end users, this is likely to lead to powerful new theories of end user innovation.
- **Disconfirming Incorrect Theories**. In addition, descriptive research often is a good way to kill bad theories. Thomas H. Huxley characterized this as a case of, "A beautiful theory destroyed by an ugly fact." In physics, experimenters typically do test theories, but they also use their data to crush bad theories and give rise to new theories. In a lecture, Richard Feynman said that experimenters are happiest when they look at data and said, "Hmm, that's funny." Nobel Prize-winning physicist Frederic Joliot-Curie said it more directly, "The further the experiment from theory, the closer to the Nobel Prize." Kuhn [7] has shown that incorrect paradigms can live a long time in the face of disconfirming data. We need to do a great deal of descriptive research if we hope to change the field's misconceptions about EUC.
- **Who Are End Users?** Finally, if we have no clear idea about who end users are and what they do and understand the diversity that exists in end user computing, what is wrong with us?

This Paper

This paper considers three pieces of descriptive research. First, it analyzes occupational data from the U.S. Department of Commerce's Bureau of Labor Statistics. The goal is to help develop a slightly more nuanced picture of types of end users. This analysis is limited but still, we believe, enlightening, especially in its placement of line management support in the context of the much broader field of knowledge worker support.

Second, it calls into question traditional views of organizational structure—especially the "Anthony pyramid" that has been used by IS researchers and teachers for many years. The goal is to show that we do not really understand organizational structure. We need to do so if we are to be able to do good sampling when we look at types of end users.

Third, this paper describes a planned research study that could give us a better picture of an important aspect of end user computing, spreadsheet-based EUC, within a professional services organization. The goal is to identify some types of data collection methods that can be used in descriptive studies of end users, of the tools they use, of the ways they use tools, and of how they innovate to be more effective.

ANALYSIS OF OCCUPATIONAL DATA

To understand end users, we need to have some idea of their numbers and of the different types of end users that exist. One particular task is quantifying the relative numbers of knowledge workers and information support workers. Another is to

question the traditional EUC focus on line managers. Governments often supply broad and detailed information about employment by occupation and industry. In this section, we will focus on some superficial data analysis that allows us to develop a clearer understanding of end users.

The Knowledge and Information Support Workforce

Although the use of computers is widespread in business today across occupations, we will focus on the "core" end user computing market—knowledge workers (managers and professionals) and information support workers (office and administrative support workers.) Table 1 shows data from the U.S. Bureau of Labor Statistics that show occupational employment in 2010. The data are more detailed than the table shows, and this detail is important in understanding the diversity of knowledge work and information support work. However, the aggregated level of data in the table shows some important patterns more clearly.

Employment Category	2010 Employment (thousands)	Percentage of Employment	Percentage of Knowledge and Information Support Employment	Percentage of Knowledge Worker Employment	Percentage of Knowledge and Information Support Wages
Total Employment	143,068	100%			
Knowledge Workers	46,086	32%	67%	100%	81%
Managers	8,776	6%	13%	19%	
Business and Financial	6,789	5%	10%	15%	
Professionals	30,521	21%	44%	66%	
Information Support Workers	22,603	16%	33%		19%
Knowledge and Information Support Workers combined	68,689	48%	100%		100%

Table 1: The Knowledge and Information Workforce
Source: Lockard and Wolf [8]

The first column gives 2010 employment in thousands. Total employment in the United States that year stood at 143 million workers. The table also shows three large occupational categories that we equate with the traditional ideas of knowledge workers. These are management occupations, business and financial operations occupations, and professional occupations. We defined professionals as occupational groups 15 through 29. There is also an occupational category, information support workers, that corresponds to what is often called the information support worker workforce. Using these definitions, knowledge workers numbered 46 million, and information support workers numbered almost 23 million. The second column shows this data as a percentage of total employment. Knowledge and information support workers constituted 48 percent of the entire workforce. This is a very large fraction.

The third column focuses on the knowledge and information support worker categories. Note that knowledge workers account for two-thirds of these workers, information support workers only a third. This is a surprise to some because many think that clerical workers outnumber knowledge workers. However, historical Bureau of Labor Statistics data show that information support workers were never a large part of the knowledge and information support workforce or of the total workforce [13]. Improved information technology is *not* the reason for the substantial but limited number of information support workers.

Many will find the breakdown of knowledge workers even more surprising. In the current Bureau of Labor Statistics categories, the "managers" category consists almost exclusively of line managers. (This can be seen by examining the detailed occupational categories.) Research in business schools has perhaps understandably tended to focus on line managers. However, line managers make up only 6% of the total workforce, and, more importantly, they make up only 13% of the knowledge and information support workforce. To understand end user knowledge workers, we cannot focus myopically on line managers.

In turn, the "business and financial operations occupations" categories corresponds to what might be called staff managers—people who are often classified as managers but who are primarily professional in their work. Note that the numbers of line and staff managers are about equal. Yet, again, IS and EUC writings tend to focus much more heavily on line managers than staff managers.

Professionals account for just under two thirds of knowledge worker category. If business and financial occupations are counted as professional occupations, which most really are, then professionals make up 81% of all knowledge workers. Again, a focus on line managers is a fundamental mistake in end user computing.

The final column shows that knowledge workers are even more important when labor cost is taken into consideration. While they account for 67% of total knowledge worker and information support worker employment, they account for 81% of total knowledge worker and information support worker labor cost. These calculations are approximate because only median salaries, rather than mean salaries, were available for occupational categories. The calculations treated medians as means. Even with this important limitation, the numbers emphasize that knowledge workers are not only more prevalent than information support workers; they are also more expensive.

Knowledge Workers by Industry

One might expect that knowledge workers who are not line managers would be concentrated in certain industries. However, Table 2 shows that the industries that probably have the most professionals are extremely large industries. Information systems courses tend to focus on manufacturing, retailing, and financial services. However, the table shows that these are not at the top of the list of industries reported by size. The top three are government, education and health services; and professional and business services. The second two have large numbers of knowledge workers. In fact, knowledge workers typically make up their "operating core." Many IS teachers are reluctant to uses cases from universities, but universities really are highly typical organization's in today's economy.

Industry	Employment (x1000)
Government	21,997
Education and health services	20,213
Professional and business services	17,789
Retail trade	14,694
Leisure and hospitality	13,587
Manufacturing	11,928
Financial activities	7,721
Wholesale trade	5,594
Construction	5,551
Other services	5,362
Transportation and warehousing	4,356
Information	2,632
Mining and logging	835
Utilities	562

Table 2: Employment by Industry
Source: U.S. Department of Commerce, Bureau of Labor Statistics [17]

Computer Use

So there are many knowledge workers in corporations. How do they use computers? Table 3 shows 2003 data from the Bureau of Labor Statistics on the use of computers by knowledge and information support workers. The first two columns show the use of computers and the use of the Internet and e-mail. It shows that 80% of all knowledge workers use computers at work, although use was lower for the Internet and e-mail. Presumably, use is higher today.

	Employed Workers		If Used Computer at Work, Used …			
Category	Used a Computer at Work	Used the Internet or E-mail at Work	Word Processing or Desktop Publishing	Internet or E-Mail	Spreadsheet or Database	Calendar or Scheduling
Knowledge Workers	80%	67%	77%	84%	71%	63%
Managerial and Related	81%	71%	80%	88%	80%	69%
Professionals	79%	64%	75%	82%	64%	59%
Information Support	74%	52%	66%	70%	63%	54%
All workers	56%	42%	68%	75%	64%	57%

Table 3: Computer Use by Knowledge and Information Support Workers in 2003
Source: U.S. Department of Commerce, Bureau of Labor Statistics [16].

The table also shows the applications used by knowledge and information support workers who used computers at work in 2003. It shows use by the "big three" applications: word processing or desktop publishing; the Internet and e-mail; and spreadsheets or databases. It also shows that calendaring or scheduling is also widespread. Not surprisingly, use of the big three is very high for managers. For professionals, use is somewhat lower. However, even for spreadsheets and databases, use is substantial by spreadsheet professionals. Hinh, Lewicki, and Wilkinson [6] described the widespread use of spreadsheets by professionals at the Jet Propulsion Laboratory in a paper named, "How Spreadsheets Get Us to Mars and Beyond."

One concern with Table 3 is that its data come from 2003. Another is that line managers and staff managers are lumped together; this is unfortunate because differences across these two groups might be highly instructive. A third concern is that all professionals are lumped together. However, the professional employment category is extremely diverse.

The End User's Day

Table 3 shows how widely many applications are used by knowledge and information support workers. However, it does not tell us how *intensively* they use applications. We would like to know, for instance, whether spreadsheet users use spreadsheets a few minutes a day or several hours per day.

One indication of use, if only for spreadsheets, is a survey of MBA alumni from two universities [3]. Respondents estimated the percentage of time they spend using spreadsheets as a whole and how much time they spend in development activities (creation, testing, and documentation). Based on data not reported in the paper but given to the first author, respondents reported that they spent 35% of their days using spreadsheets, including 25% of the day in spreadsheet development. This survey only asked about spreadsheets, and the response rate was low, so the respondents may have been atypical. In addition, people are not good at estimating time use [13]. However, this data indicates that spreadsheet use is relatively intense and that we need to do more detailed use analyses of spreadsheets and computer applications in general.

In the 1970s and a little later, researchers produced a stream of more than 50 use-of-time studies that examined how various types of employees spend their day. The best known was the study by Mintzberg [10]. However, Mintzberg only looked at top executives. Table 4, which summarizes data from use-of-time studies, shows that executives, middle managers, and professionals have very different time use profiles [13]. Although these studies took place over many years, patterns of time use were remarkably similar across time [13].

Use-of-Time Category	Executives	Managers	Other Knowledge Workers
Oral (spoken) Communication			
Face-to-face meetings	70%	55%	25%
Telephone	?	5%	?
Total oral	75%	60%	35%
Written Communication	?	25%	25%
Total Communication	?	85%	60%

Table 4: Historic Use of Time Patterns of Knowledge Workers
Source: Panko [13].

Although use-of-time profiles vary strongly by type of knowledge worker, communication dominates all time-use profiles. This is even true in the professionals category, which takes data from laboratory chemists and software developers.

Unfortunately, none of these studies included computer use. All were done before widespread computer use. We need new use of time studies to see how different time use profiles are today, in this era of explosive growth in mobile communication and hand-held devices.

The Familiar Unknown

The discussion in this section has given a highly incomplete picture of end users. However, several of the gross statistical data points in this section may be surprises to the reader—especially the relatively small size of line management employment compared to total employment and knowledge worker employment. We need to do far more descriptive research to understand end users before we can confidently say that we are not dealing with stereotypes.

UNDERSTANDING CORPORATIONS

Part of understanding end user computing in organizations must be understanding how corporations and non-profit organizations are organized. Information systems textbooks tend to focus on relatively simplistic models that were often not meant to be models of organizations in the first place. We need realistic models of corporate organization if we are to understand the diverse roles of end users.

The "Anthony Pyramid"

The most common way to depict organizations in IS textbooks probably has been to use a pyramid based loosely on Anthony's [2] work, which was primarily introduced into the IS literature by Gorry and Scott Morton [4]. Figure 1 shows that the pyramid focuses on three levels of management. There is strategic planning at the top, management control in the middle, and operational control at the bottom.

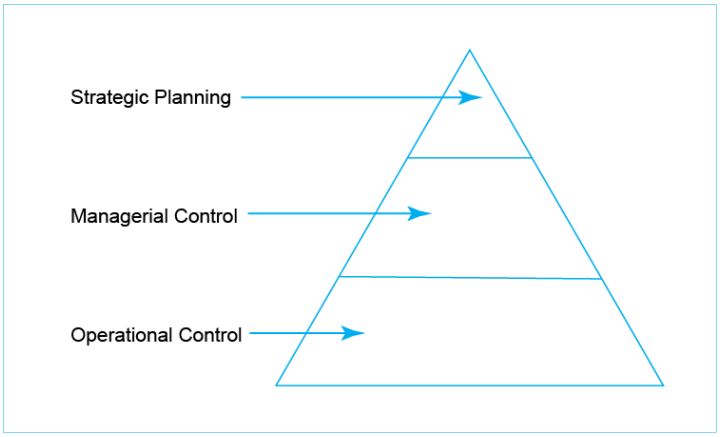

Figure 1: The Traditional Information Systems Pyramid Model of Organizations

The layers of the pyramid are typically interpreted as layers of management, with executives at the top, middle managers in the middle, and operational managers at the bottom. The pyramid is wider at the base than at the top, and this is typically interpreted as meaning that there are relatively few executives, more middle managers, and many more operational managers. The bottom layer is often viewed as consisting not only of operational managers but also of operational workers.

However, Anthony [2] never intended his trichotomy of strategic planning, management control, and operational control to be a description of corporate structure. Neither did Gorry and Scott Morton [4]. Anthony focused on *management* planning and control, as the title of his book indicated—not on other aspects of corporations. Figure 2, which is taken from his book, illustrates that Anthony was attempting to divide managerial planning and control tasks into a simple but correct structure and

to discuss interactions among these structural elements. The model is completely mute on other aspects of corporate work and organization.

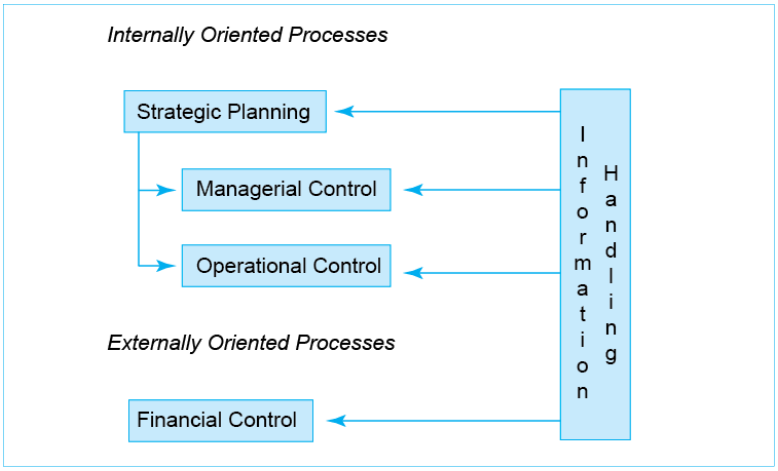

Figure 2: Anthony's Planning and Control Framework

Although Anthony [2] and Gorry and Scott Morton [41] did not interpret Anthony's model as a model of corporate structure, the mutated interpretation did get into the MIS literature and MIS education. For example, Williams and Heinrichs [19] proposed that the entire MIS curriculum be modeled on "Anthony's pyramid." Information systems would be strategic systems, management systems, and operational systems. Many textbooks reflected this mutation. This has unfortunately sharpened information systems' myopic focus on line management.

Mintzberg's Model

The management literature, in contrast, does not see organizations only in terms of management. Mintzberg [11] conducted a survey of research studies on organizational structure. Figure 3 shows his model based on this review. At the top, there is the familiar executive group. However, in the middle there is a thin stem of line managers, which is consistent with the data we saw earlier on the small number of line managers in organizations. Instead of there being a fat band of middle managers, Mintzberg shows two broad types of functional units that interact with executives, line managers, and operational groups. Some of these are support functions such as human resources. Others execute some degree of control over managers and operational units. An example today might be corporate security. Although Mintzberg's [11] model of corporate structure is an antidote for the classic IS pyramid's preoccupation with line managerial, it is still only a sketch of what organizations really look like.

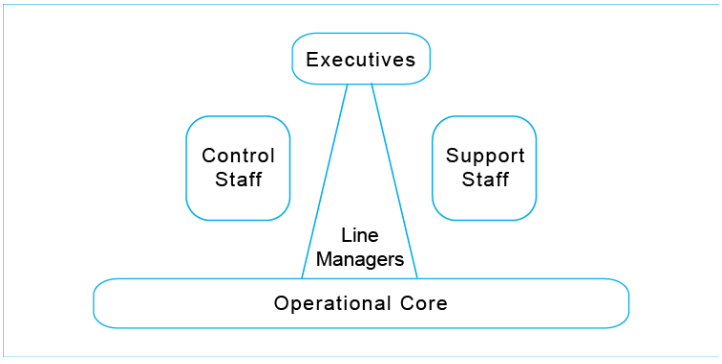

Figure 3: Mintzberg's Model of Corporate Structure

Porter's Value Chain

Although the classic IS pyramid has long been influential in IS thinking, teaching, and research, Porter's [15] Value Chain has more recently become widely cited in information systems. Porter's model shows a value chain consisting of inbound logistics, operations, outbound logistics, marketing and sales, and service. Each of the five "links" in the value creates value directly and by enhancing the value of other links in the chain. Assisting these primary activity links are support activities, including firm infrastructure, human resource management, technology, and procurement. This model offers valuable insights, but the value chain approach is questionable as a model for organizational structure. While it makes intuitive sense for manufacturing, it seems more difficult to apply to university education, hospitals, and other professional services. In any case, it was never intended to be a detailed model of how companies are structured.

Conclusion

To understand end users, we must look beyond line managers. This means replacing the traditional pyramid with a more accurate, although probably far messier, understanding of how corporations are structured. In addition, this is only the formal structure of organizations. The informal connections that cut across the formal organizational structure are likely to be messier yet more important still.

A PLANNED RESEARCH STUDY DESIGN

To begin addressing the need for descriptive research, we consider a planned research study of corporate organization and end users in a professional services organization. As noted earlier, professional services organizations are the third largest industry in the United States, and this industry has been understudied. This would also give us a large base of professionals to study. Ideally, these professionals would be mostly engineers who are skilled at programming in third generation languages (3GLs). This would help us understand when and why professionals capable of programming use end user fourth-generation tools like spreadsheets.

Rather than focusing on end user computing broadly, this research design focuses on spreadsheet development and use. There are several reasons for this. End users often use spreadsheets to develop large and complex applications [14]. McDaid, MacRuairi, Clynch, Logue, Clancy, and Hayes [9] examined the spreadsheets of a two financial departments with a total of 30 professional workers. They found almost 66,000 spreadsheets—more than 2,000 per professional employee. These spreadsheets were large, averaging over 4,000 formulas. Spreadsheets are also important, in many cases mission-critical [5,18]. These applications have great potential for innovative use.

At the same time, spreadsheets can be risky. For example, the use of spreadsheets of material importance is frequent in financial reporting processes, which are subject to stringent sanctions under the Sarbanes–Oxley Act of 2002 [14]. In addition, despite the size, complexity, and importance of spreadsheets, many corporate managers and IT professionals continue to view spreadsheet development as a *personal productivity* application devoid of wider importance to the firm.

The Initial Visit

Organization Profile

At the start of the study, the research team would meet with appropriate corporate officials to develop an organizational chart that would include headcounts in various units. Discussions would be conducted to understand how the units are interrelated. This understanding of the organization would be needed to understand the situation and to develop a sampling approach.

Focus Groups

In the initial visit, the researchers would also conduct two focus groups involving about ten professionals. Goals would be to identify categories of spreadsheet use, the amount of spreadsheet use, the importance of spreadsheets, and why professionals use spreadsheets instead of writing programs or using packaged software, including the organization's central transaction processing systems.

Discussion with IT

The researchers would also meet with the IT staff to understand central systems in the organization.

Subsequent Visits

During subsequent visits, two interrelated studies would be conducted—a profiles study and an issues study.

Profiles Study

The purpose of the Profiles Study would be to develop a good statistical profile of the spreadsheets used in the organization. This would require 50 interviews with professionals and managers. In each interview, the employee would bring up Excel (or other spreadsheet program) and note his or her four most recently used spreadsheet files. The researcher would temporarily copy these files to a thumb drive for analysis. Marketing research has long used this type of recent-use sampling [12].

Next, the interviewer would also ask the interviewee to identify his or her *most important* spreadsheet file. The research will also copy this file to the thumb drive.

The interviewee would then describe the five spreadsheet models, including what the models do, how they do it, how important they are, why they were developed using spreadsheet program, what issues the interviewee encountered working with them, and what issues they may raise for the organization.

After the interview, the research team would analyze the five spreadsheet files using Spreadsheet Professional. For each model, the program would generate a report describing the spreadsheet in terms of number of worksheets, number cells, number of formulas, number of original (non-copied formulas), the use of various functions (such as IF), and similar information.

In total, this study would give a statistical profile of spreadsheets in the organization, important spreadsheets in the organization, and what issues they raise.

Issues Study

The Issues Study would not collect spreadsheet files. Instead, the interviews would probe for more subtle patterns. The interviews would begin with questions on participant background, including IT experience, programming experience, spreadsheet experience, and database experience. The interview would continue into how and why the interviewee uses spreadsheets, the importance of their spreadsheets, and what issues their spreadsheets raise. As in the Profiles Study, the interviewee would identify his or her most important spreadsheet and discuss it. There will also be a critical incident component, in which the participant would first identify an important decision the interviewee or work unit made recently. He or she would be asked which information sources were used and how important they were in the decision.

Ideally, the two studies would be collapsed into one. However, this would require interviews that take more than an hour. Pilot studies would ideally be done on the first visit to measure time requirements.

CONCLUSION

In this paper, we discussed the importance of doing exploratory descriptive research in end user computing. With data from such studies, we can better select research targets based on issue importance, reduce the field's overdependence on theory that is not backed by extensive data, develop new theory, and correct misbeliefs about EUC. Typically, researchers do exploratory descriptive research most heavily early in a field's life, but end user computing changes so rapidly that it is *always* early in the life of the field.

The paper looked at U.S. national occupational data. It focused on knowledge workers, who arguably have the strongest potential for making innovative use of end user computing tools. It showed that knowledge workers comprise a substantial part of total employment and an even larger fraction of total employment costs. It also showed that line managers make up only a modest fraction of all knowledge workers. It focused on the importance of professionals in diverse fields, who probably have very different needs for EUC tools and probably use these tools in different ways. To do exploratory descriptive research, we will need to sample end users. This paper showed that such traditional views of organizational structure as the "Anthony pyramid" and the Porter Value Chain model will not allow us to do good sampling given the far greater complexity that exists in organizational structures.

The paper ended with a description of a planned research project to do exploratory descriptive research in a professional services organization. The study would focus on end user computing with respect to spreadsheet development. This topic was chosen because spreadsheets are not just personal productivity tools. Many are large, complex, and very important to the firm—sometimes mission-critical. They also create substantial risks to corporations, and these risks need to be better understood.

REFERENCES

1. Anderson, J.R. (1987) Methodologies for Studying Human Knowledge, *Behavioural and Brain Sciences,* 10, 467-505.
2. Anthony, Robert N. (1965) Planning and Control Systems: A Framework for Analysis, Division of Research, Graduate School of Business Administration, Harvard University, Boston.
3. Baker, Kenneth R.; Foster-Johnson, Lynn; Lawson, Berry; and Powell, Steven G. (2006) A Survey of MBA Spreadsheet Users, *Proceedings of the European Spreadsheet Risks Interest Group (EuSpRIG)*, 205-219
4. Gorry and Scott Morton (1971) A Framework for Management Information Systems, *Sloan Management Review*, 1971. Republished by the Sloan Management Review in Spring 1989, pp. 49-61, with additional comments by the authors.
5. Grossman, Thomas A.; Mehrotra, Vijay; and Ozluk, Ozgur. (2007). "Lessons from Mission-Critical Spreadsheets*," Communications of the Association of Information Systems*, *Vol. 20,* 1009-1042.
6. Hinh, Jairus; Lewicki, Scott A., and Wilkinson, William B. (2009) "How Spread-sheets Get Us to Mars and Beyond," *Proceedings of the Forty-Second Hawaii International Conference on System Science*, IEEE, January 2009.
7. Kuhn, Thomas S. (1962) *The Structure of Scientific Revolutions, 1st. ed.*, University of Chicago Press, Chicago.
8. Lockard, C. Brett and Wolf, Michael (2012, January) Occupational Employment Projections to 2020, *Monthly Labor Review*, 84-108. Table 1: Employment and wages of major occupational groups, 2006, 2010, and projected 2020. http://www.bls.gov/opub/mlr/2012/01/art5full.pdf.
9. McDaid, Kevin; MacRuairi, Ronan; Clynch, Neil; Logue, Kevin; Clancy, Cian; and Hayes, Shane. (2011) "Spreadsheets in Financial Departments: An Automated Analysis of 60,000 Spreadsheets Using the Luminous Map Technology," *Proceedings of the 2011 European Spreadsheet Risks Information Group*.
10. Mintzberg, Henry (1971) Managerial Work: Analysis from Observation, *Management Science*, B97-B110.
11. Mintzberg, Henry (1979) *The Structuring of Organizations: A Synthesis of the Research*, Prentice-Hall, Englewood Cliffs, New Jersey.
12. Myers, J. H., & Tauber, E. (1977) *Market Structure Analysis*, American Marketing Association, Chicago.
13. Panko, R. R. (1992) Patterns of Managerial Communication, *Journal of Organizational Computing, 2*, 1, 95-122.
14. Panko, R.R. and Port, D.N. (2012, January) End User Computing: The Dark Matter (and Dark Energy) of Corporate IT, *Forty-Sixth Hawaii International Conference on System Science*, Kihei, Maui.
15. Porter, Michael E. (1985) *Competitive Advantage: Creating and Sustaining Superior Performance*, Free Press, New York.
16. U.S. Department of Commerce, Bureau of Labor Statistics, (2005, August 2) *Computer and Internet Use at Work in 2003*, press release. http://www.bls.gov/news.release/History/ciuaw.txt.
17. U.S. Department of Commerce, Bureau of Labor Statistics, (2012, April 6) Economic News Release, Table B-1. Employees on nonfarm payrolls by industry sector and selected industry detail. March 2012 data, seasonally adjusted.
18. Wagner, J. (2003). "Mission Critical Spreadsheets in a Larger Urban University." *INFORMS*, Atlanta, GA, October 2003.
19. Williams, Gary A. and Heinrichs, Lynn R. (1993, Fall) A Proposed MIS Curriculum Modeled on Anthony's Pyramid, *Journal of Information Systems Education, 5(3)* 17-22.