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Managing End-User System Development: Lessons from a Case Study

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ABSTRACT

How much end-user computing is too much? Should end users develop systems? This paper reports on a study of the engineering organizations within an electric utility undergoing deregulation. The study was initiated when management perceived that too much engineering time was spent doing IS functions. The study found that there was significant effort being expended on system development, support, and ad hoc use. Several issues were identified affecting system development, use of programming standards, documentation, infrastructure integration, and system support.

INTRODUCTION

Due to deregulation the subject utility organization assessed its engineering staffing. They determined their staffing needed to be lowered by approximately 25%. A change management team was formed for identifying where work effort could be reduced. During this process it was noticed that the engineering organizations were spending significant amounts of time and effort on information technology (IT) related tasks. To assess this IT usage a team was formed consisting of engineering and information systems (IS) representatives and led by the author, a former member of the engineering organization and at the time of the study, a member of IS. The team collected an inventory of IT products and resources used by engineering organizations but not supplied, supported, or controlled by IS. The team also assessed how IT usage could be better managed by engineering.

The team found a significant amount of effort expended by engineering on IT including system development and significant system support and ad hoc reporting efforts. Analysis of these efforts found several problems that caused additional wasted efforts and significant expenditure of additional funds. This analysis provides insight into how an organization can better manage end user computing (EUC).

BACKGROUND

The subject organization's Year 2000 (Y2K) effort documented 151 applications supported by Engineering where the support consists of personnel and/or annual renewal/licensing costs. Additionally, IS supports another 11 applications used by engineering. Finally, discussions with various managers and supervisors indicated that there was a number of 'local' databases and programs developed and/or supported within engineering. Also, there was a perception that significant engineering resources were being used to support IT needs due to a lack of support by IS for engineer IT needs.

EUC is the adoption and use of IT by personnel outside of the IS organization to develop applications to support organizational tasks (Powell and Moore, 2002). Reviewing the literature found few sources related to end user system development. Dodson (1995) and KPMG (1999) warned of the dangers of unmanaged end user system/application development but provided little guidance into how to manage this development. Munkvold (2002) found that high computer skill self-efficacy within end users coupled with a low regard for IS leads to end user system/application development. Wagner (2000) investigated the use of end users as expert system developers and found that end users have significant domain knowledge. However, it was also found that end users had difficulty knowing and expressing what they know, making their contribution limited in content, quality, size, and scalability. Taylor, et. al. (1998) agrees that end users do not produce good systems and identified duplication of effort, low quality, and lack of training in system development methodology as issues. However, McBride (2002) found that imposing system development methodology on end users might be regarded as an attempt to impose IT culture. Finally, Adelekun and Jennex (2002) found that EUC development issues could be caused by end users not identifying appropriate stakeholders for assessing success of end user developed systems/applications.

METHODOLOGY

The team consisted of engineers serving as computer representatives/liaisons, considered to be subject matter experts (SMEs) and IS personnel serving in the engineering support systems group. The author served as project manager. Data was collected using informal surveys and interviews, and forty structured interviews. The process was to first generate an inventory of IT applications used by the engineering organizations but not maintained by the IS group. The scope of the inventory was any specialized software/hardware for data collection, testing, and analysis, specialized databases, any software used for system development, any generic software that was being customized through the generation of macros, scripts, or programs, and any other software/hardware assessed to be important to engineering and worthy of inclusion. A first cut inventory was generated using the Y2K inventory. This was validated using surveys/interviews to validate the Y2K inventory and to expand the inventory as necessary.

The second step was to generate a list of IT resources existing within each engineering organization. IT resources were considered to be engineers with IT skills in demand by their coworkers such that they spent significant amounts of time assisting management or their group with IT support. The initial list of resources was developed by the SMEs. After conducting 40 interviews of selected individuals, the list was finalized by the project manager. A set script was used for determining what amount of IT support was being provided by engineers to engineers, any additional inventory items, general levels of automation and needed IT, and what issues were involved in using IT in engineering. Interview subjects were selected based on input from the SME's and known expertise and/or participation in IT development.

The final step was to take the gathered data, analyze it with respect to dollars and time invested as well as issues identified, and generate a set of recommendations for improving management of the IT effort in the engineering organizations. This was documented in a final report by

Jennex, et. al. (2000) that was presented to IS and engineering management and is used as the data source for this paper.

FINDINGS

The assessment found a significant but poorly managed investment in IT in terms of money, time, and expertise. With respect to the management of IT, it was observed that IS is tasked with managing the infrastructure, networks, and enterprise level applications. This provides an overall organizational perspective and strategy for managing these assets. Engineering IT is managed at the division level and was found to lack an overall engineering strategy for the use, adaptation, and implementation of IT. Additionally, IT was unevenly applied throughout the engineering divisions. Some groups were fully automated; others with process steps automated but not the overall process; and still others were not automated at all. The net effect was that IT assets were not performing as effectively as they could and many engineers were expending more time and resources than they should to obtain the information and data they needed. Specifics on these findings are provided in the following paragraphs.

Investment

The inventory recorded 267 applications with supporting hardware. This number excludes enterprise work process systems, basic personal productivity applications (MSOffice, WordPerfect, Access, etc.), and plant control applications. Included are the analysis tools, graphics packages, scheduling tools, equipment databases, image and web editing and authoring tools, and data collection tools used by engineers. The team was confident this number reflected at least 90% of what was in use. The investment in terms of dollars and effort was not totally determined, not all numbers were known and not all groups were willing or able to report all costs. However, with about 30% of the inventoried applications reporting this data it was found that approximately $1,650,000.00 had been spent to purchase these applications with an additional 5 person years (during the last 2 years) expended on development. Additionally, $290,000.00 was spent annually on license or maintenance fees and 10 full time equivalent engineers (FTEs) were expended maintaining these applications. Finally, an additional approximate 10 FTEs were expended assisting other engineers in the use of these tools. For political reasons there were significant exclusions from these figures including 45 FTEs and $335,000.00 in annual licensing cost supporting plant control IT. The team was confident that purchase and support costs and efforts would at least double if all the information was available. For perspective, these numbers were not expected and were considered by management to be extremely excessive although Panko (1988) found in the 1980s that 25-40% of IT expenditures were in EUC and not under IS control.

Engineer Involvement in IT

It was observed that engineers supported IT three ways; supporting other engineers' use/acquisition of IT, learning to use the IT, and maintaining applications; building queries, macros, and reports for special/ad hoc information requests; and developing IT solutions for supporting engineering processes. It was reported previously that approximately 20 FTEs were expended for the first item and approximately 5 person/years were expended (over the last 2 years) for the third item. Doubling these values (per the team's estimate) gives 45 FTEs/year for items one and three. The second item was found to take approximately 5% of each engineers' time. Taken as a whole this is a fairly extensive activity, approximately 21 FTEs yearly. Combining these efforts and excluding assets dedicated to plant IT support, approximately 66 FTEs/year (14%) are spent on IT functions. This was considered excessive.

The need for engineering to provide their own IT support was attributed to several reasons but is due primarily to three issues. The first is that engineering applications are generally not supported by IS so expertise to assist engineers with these applications only exists in engineering. The second is that due to lack of standardization there are multiple products supporting the same function, this makes having central support prohibitively expensive, experts would be needed for over 200 applications and devices that in many cases are only used by a few people. The third is a suffering relationship between engineers and IS.

The ability to do ad hoc reporting was considered a tremendous strength. The team did not see the need for ad hoc reporting decreasing. However, there were several issues that caused the time needed for this activity to be greater than it needed to be. Chief among these are a lack of standard query/reporting tools, a lack of advanced training in the use of the available tools, and a lack of integration of the site databases resulting in more complex and time consuming query/report generation.

The ability to develop new systems for addressing specific engineering problems was considered a strength and a need by the engineering organizations. The team agreed that this function would continue to require engineering involvement. However, this is the function least understood by engineering with respect to cost and process. Engineers followed minimal processes and considered the Capability Maturity Model, CMM, processes followed by IS to be a waste of time and money (IS is a CMM Level 2 shop). The processes followed by engineering need to be formalized so that resources applied to project development are accounted for, the highest priority projects are performed first, projects are performed cost effectively, and the resulting systems are documented and designed to IS standards (this reduces maintenance and conversion to enterprise application costs).

Other Issues Affecting Engineer Involvement in IT

There are many plant digital systems that are approaching their end of life and need to be updated. Systems were found running on Windows 3.1 and DOS as well as using 8" and 5 1/4 " floppy drive technology. Expertise and hardware for maintaining these systems is disappearing. Problems arise as replacements are investigated for these systems and as new equipment/software is purchased for resolving new problems. Infrastructure is standardized on proven technology and is not leading edge. Engineers tend to buy leading or even bleeding edge products. This results in some new products not being able to function within the IS environment and requiring engineers to purchase equipment of an older standard. However, it is not good practice to develop replacement systems for the older infrastructure in place, instead, developers need to anticipate where the infrastructure is going and design for that. The issue is how to incorporate leading edge solutions needed by engineering into the IS infrastructure while maintaining the reliability and coherence of the infrastructure.

There is a great deal of memory stored in systems no longer supported by IS. Also, there is a great deal of knowledge as to why things are done a certain way built into macros, programs, reports, databases, and models that is not captured in a retrievable manner. As engineering undergoes change there is a potential for a great deal of this knowledge to be lost. Additionally, engineering's current knowledge management practices assume a static work force and will not work well with a changing work force.

Digital cameras and the use of digital images are rapidly growing. Their use has had a very positive impact on productivity. However, due to a lack of standards on types of equipment, software, and formats there exists the potential for the benefits of the productivity improvement to be lost to slower network speeds, dealing with different formats, and incorporating images into processes not designed to handle them.

Use of the external Internet has had significant productivity benefits with respect to research and document and contact information retrieval. However, use of the internal Intranet has had lesser results. This is attributed to a lack of a web strategy, resources, and standard tools/design practices.

It was observed that the distinction between the business systems maintained by IS and plant systems maintained by engineering is blurring. Plant information flows across the business network on a routine basis. Plant processes have been developed that rely on email to transmit data. Plant support productivity has improved by using the business networks to access and maintain plant systems. The key issue is to recognize that the boundary for protecting plant information now extends to the Intranet firewalls.

ANALYSIS

What these findings show is that left unmanaged, EUC can cause organizations to shift significant resources away from their central focus or function. They also show that an IS group that focuses on providing enterprise level systems can fail to support specific user needs. While this is predominantly an IS management issue, there are two issues specific to IS development. The first is the issue of end user IS development that does not follow IS standards. This case found end-user applications that did not have documentation, were low in quality, or that were designed such that they could not interface with the organizational infrastructure. These findings result in much higher maintenance costs. To illustrate these problems, two applications were found that the team was told "unofficially" cost a total of approximately $1,000,000.00 with neither able to perform the function it was purchased for due in total or in part to incompatibility with the infrastructure. The engineering group paid IS approximately $40,000.00 in labor costs to make one application work. The other application was abandoned after IS spent approximately one-person week working with the vendor to see if it could be made to work and determining that it could not. Both applications were built without consideration of IS standards for the operating environment and consulting the appropriate stakeholders with the result that neither worked. Additionally, neither utilized IS standard interfaces or programming guidelines causing low quality and making both difficult to understand and work with from the IS developer viewpoint. While these two examples are the extreme, they were not isolated cases. Numerous examples were found where engineering groups bought or developed hardware and/or software without regard for IS development standards with the result that additional effort was required to get the hardware and/or software to initially work or to maintain it over its useful life.

There is also a potentially large problem with those applications and systems developed without documentation. An example was an application developed to model the fire protection system. The application is used to evaluate potential work activities to determine impact on the fire protection system and to determine what compensatory measures need to be taken to ensure the fire protection system will still function when portions of it are taken out of service for maintenance. The application was designed, built, maintained, and supported by the fire protection engineer. No documentation was found. The concern is what happens if this engineer leaves, as a replacement has nothing to learn from. The organization has grown to rely on this application and its loss would severely impact the organization. Again, this was not an isolated case. Numerous examples were found of special reports, databases, spreadsheets, and applications that were built to satisfy specific needs but which are not documented. All rely on the engineer using them to maintain and enhance them and would be lost should the engineer leave and the report, database, spreadsheet, or application have a failure or need to be modified.

What makes these issues significant to this and all organizations is that it has the potential to lead to inaccurate data and incorrect decision-making. Research into spreadsheet errors by KPMG (1999) and Panko (2000) found very high incidence of errors. KPMG (1999) suggests implementing standards in design. Dodson (1995) expects up to 80% of system development will be by end users and that if done without standards and standard methodologies will result in high maintenance costs. It is suggested by this study that doing end user development according to IS development standards is important.

The second issue is the large amount of ad hoc reporting. This can be reflective of several problems. It can be due to simply having lots of unstructured questions requiring ad hoc searches and queries. It can also be due to enterprise database systems not addressing requirements of sub-organizations and being poorly organized and documented. Interviews recorded numerous complaints of end users not knowing where data was. Engineers that spent significant time assisting in ad hoc reports and queries stated that their time was taken in assisting with SQL and finding out where data was kept. To address this the organization is considering publishing a data road map. Another problem are standard reports. There is no process for tracking end user reports to determine if they are used in sufficient quantity to warrant inclusion in the enterprise system. The team did not consider this very important but from the interviews it appeared that there were several organizations doing the same or similar reports. Discussions with IS and end user managers found no awareness of what reports and queries were being run although both groups expressed interest in making repeatedly run reports and queries part of the formal system. This leads to the key issue of IS focusing on the enterprise level and allowing end users to go their own way. This case is an example of more effort than necessary being expended on ad hoc reporting because the enterprise database structure was not available to the end users and no effort is being made to monitor end user usage for common reports and queries. Dodson (1995) found that these are common problems when IS focuses solely on the organizational systems. What makes this issue more significant is the ability to generalize the average of 5% time spent on ad hoc reports to other organizations. This was considered excessive by the engineering organizations' management and would probably be considered excessive in most organizations. One of the more interesting questions for further research is what level of ad hoc reports and queries is acceptable. Perhaps the most interesting observation during the study was the generally held opinion that the ability to do ad hoc reports was a great strength. While this is an indication of system flexibility and end user ability, it did not occur to anyone that large amounts of ad hoc reports and queries could also be a negative indicator.

CONCLUSION

The major conclusion is that EUC left on its own is costly. This is especially true for end user system development and leads to the proposition that end user system development should be performed just like IS system development. The earlier examples of the two systems purchased for approximately $1,000,000.00 that did not work are even more striking when it is realized that the IS department estimated they could have designed and built both systems for approximately $250,000.00. This estimate was based on using in house knowledge and expertise, standard objects from the IS object library, and existing infrastructure. That the IS department was not considered for this work is indicative of the low level of trust between the organizations. The primary recommendation for getting end user system development to implement IS design standards is to create end user led development teams that use IS developers as resources. Another possibility is training and qualifying end user system developer as IS developers and including training on IS design standards. Ultimately the findings of Wagner (2000) and Taylor, et. al. (1988) are reflected in this case.

A secondary conclusion is that EUC should be monitored and expectations as to what are acceptable levels of activity established. The purpose of this monitoring is to ensure that productivity improvements due to incorporating common end user activities into the organizational systems are realized.

In conclusion, this case illustrates that EUC problems identified in the 1980's have not changed. This leads to the conclusion that while it appears interest in EUC has waned (based on the author's perception from doing the background research for the paper and serving as EUC track chair for the 2003 Information Resource Management Association conference) the need for continued research in EUC is still great.

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