

THE USE AND ADOPTION OF COMPUTED - AIDED SOFTWARE ENGINEERING TOOLS IN SOFTWARE DEVELOPMENT ORGANIZATIONS IN NIGERIA

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Abstract

This paper describes an exploratory study of how software development houses or organizations in Nigeria are using Computer Aided Software Engineering (CASE) tools. A survey was carried out in some selected software development organizations and their level of tool usage was addressed. Interviews conducted with Information Systems Managers in four different organizations supported the survey data. The types of CASE tools differ in each of the organizations, and a CASE tool is viewed as a general framework of activities in the organizations visited. The impact of tool maturity in each of the organization visited was also addressed. This research will help Information System managers and software developers to develop systems that will function accurately, delivered within schedule, at minimal cost and be acceptable by their clients.

Introduction

Automated software development came into existence in 1970 and has gained much ground in the development and control of large and complex software projects. Computer - Aided Software Engineering (CASE) is the application of automated technologies to the software engineering procedures (CAS, 1986). CASE therefore encompasses all forms of computer-based support for any of the managerial, administrative or technical aspects of a software engineering project. Fishers (1988) observed that CASE tools could be used to implement many software development methodologies and that programming languages are the materials in which tools operate upon. CASE involves applying the powers of computers to the software process and it can be as simple as a single tool to support a specific software engineering activity (tool kit) or as complex as a complete environment (tools that support all life cycle phases) that encompasses tools, databases, people, hardware, networks, operating systems and standards (Hopkins, 1997).

The number of CASE tools currently available is staggering. CASE tools have been developed to aid in virtually every aspect of software development. Stobart (2000) summarizes the potential benefits of CASE tools as follows:

- They promote an interactive development environment;
- They reduce the cost of developing software especially during the maintenance phase;
- They improve software quality;
- They reduce the time required to develop software;
- They promote consistency, which improves accuracy;
- They make it practical to use structured techniques; and
- They increase productivity.

As with any tool, however, it must be stressed that these benefits will be fully realized only if the tool is used correctly.

CASE tools have generated much interest among researchers and practitioners as potential means for easing the software development and maintenance burden threatening to overwhelm information technology department. While interest and investment in CASE tools have been rising steadily, actual experiences with tools have exhibited more ambiguity. For examples, while some studies report improvements in productivity from the use of CASE tools (Banker and Kauffman, 1991; Norman and Nunamaker, 1989), others find that the expected productivity gains are elusive (Card *et al.*, 1987; Yellen, 1990) or eclipsed by lack of adequate training and experience, developers resistance and increased design and testing time (Norman *et al.*, 1989; Vessey *et al.*, 1992.)

Despite the potential benefits of CASE tools, their use is not universal. Even when an organization does introduce CASE tools, often the tools are not used at all or only a fraction

of their capabilities are used (Kemerer, 1992). The greatest problem appears to be the high cost associated with investing in a CASE tool. An organization must first adopt standards for their design methodology before they can choose which CASE tool to use. All developers in the organization must adhere to that methodology in order to realize the full benefits of CASE tool. It is a daunting task to achieve complete acceptance of such standards since the practitioners in an organization typically differ with respect to their capabilities and their preferred styles of work (Albizuri-Romero, 2000).

CASE tool adoption and use in industry has also received attention from Information System (IS) researchers explaining motivations for adoption and use both quantitatively to identify predicting factors and qualitatively to develop insight into social and political forces (Fichman, 2000; Fichman and Kremerer, 1999; Iivari, 1996; Aaen *et al.*, 1992 and Rojas *et al.*, 2001). Notable research findings show that CASE acquisition does not insure adoption and use (Fichman, 2000). Although many controversies surround the adoption and use of CASE tools, most software organizations are unaware of the heights CASE can take them to especially in terms of the final product quality and overall project management.

To date, there has been no systematic examination of the evaluation or use of CASE tools in practice. Much of the literature on CASE tools has tended to focus on discrete outcomes, such as productivity, system quality and development cost, while neglecting the extent of use and adoption by key players. It is not known if CASE tools are used, how effectively they are used, or whether they are useful at all. Much of Information System development research assumes that CASE tools are used, and (hat they are useful and effective. The purpose of this research is to discover how CASE tools are being used in organizations. Specific issues addressed are what types of CASE tools are being used, which tool category is being adopted, and at what stage in software development process are such tools used.

Research Method

Structured (Questionnaires and unstructured approach - Key Informant Interviews (KII) was used to elicit complementary information about the issues of interest.

Questionnaire

Questionnaire was developed to gain an insight of the type of CASE tool used in the sample organization. Seventy (70) structured questionnaires were randomly distributed to software organizations (Industrial, commercial and academic) in five states in Nigeria namely; Lagos, Edo, Rivers, Kaduna and the Federal Capital Territory (FCT). The choice of these states is informed by the metropolitan nature of the organizations and the fact that most software development activities are clustered around these states. Lagos remains the commercial and financial nerve center of the nation and the Federal Capital Territory is the seat of government where most public sector organizations are domiciled. In total, fifty-six (56) of the questionnaires were properly completed and used for the data analysis. Table 1 presents the summary questionnaire administration and responses.

Industry Classification	Frequency	Percent (%)
Government/Public Service	3	5.4
Banking and Finance	5	8.9
Professional Bodies/Training Institutions	7	12.5
Commerce	2	3.6
Consultancy and Management Service	18	32.1
ICT (Information Communication Technology)	21	40.4
	56	100

Table 1: Questionnaire Administration Responses

Key Informant Interviews (KII)

While survey provides a broad overview of the use of CASE tools in today's organizations, additional information is required to understand how organizations are using and adopting their CASE tools. To understand the motivations for using or adopting a particular CASE tool, a more in-depth approach is needed. To this end, the key informant interview was used as the complementary instrument of this survey. It involved in-depth

personal interviews with experienced developers in a number of organizations. The issue of sample selection was important, in that given the small number of organizations that can realistically be included, one needs to use a selection strategy that can serve as a lens to magnify the research topic. Thus Patton(1990) recommends an intensity sampling strategy whereby cases which represent categories of extreme interest are focused on in more detail. This was addressed in this study by selecting four organizations either using or not using CASE tools for their software development activities.

The sample organizations were required to provide the needed information, as major developers of software and users of CASE tools. The respondents included Chief Executives or heads of Information and Communication Technology (ICT) centres; project team leaders and software developers (systems analyst or programmers) in the sample organizations. Where the chief executives could not avail the time, the authors sought wider information by interviewing more than one key informant. The authors interviewed different executives of the various organizations visited about their experiences in developing software with CASE tools. The duration of interviews ranged between 30 minutes and 90 minutes. The executives were requested to freely express their opinions on the strengths and weaknesses of developing software using CASE technology. The Chief Executives or IT managers were also asked to describe their software development activities, types of CASE tools used and at what stage in software development they use CASE tools. Results from this analysis is expected to give us a clearer understanding and hints as to how to promote the use of CASE tools in Nigeria.

This research is a first step in understanding the nature of CASE tools in use and the extent to which they are used. This sample may not be representative of IT organizations in general, nor may their experiences, but it is through a database of such experiences that CASE tools adoption, their shortcomings and maturity level in software development activities can be understood in today's organization.

Research

Results

Survey Results

Of the 70 organizations, 56 returned usable questionnaires, resulting in a response rate of 80% and the responding organization were representative of the target sample. From the target sample, we discovered that software development organizations are involved in software activities, which can lie classified into three major areas namely:

For each activity or set of activities, specific tools that can be adopted by organizations were discovered. The CASE tool categories are as shown in Table 2. This list was compiled based on a survey of the practitioner literature and discussions with practicing system developers.

The first part of the survey addressed the characteristics of CASE tools used. Since the focus of the study is not to identify individual software engineering tools, the questions addressed the general types of CASE tools and the characteristics of CASE tool that the responding organization identified as important.

Technical Tools	Development Tools	Administrative Tools
Version control	Screen generators	E-mail
Data dictionary	Graphical editor	Spreadsheet
Methodology support	Converters	Word processors
Diagramming	Debuggers	Project Management
Restructures	Report generators	Risk Analysis
Consistency checker	Code generators	Statistical Analysis
Database Management	Syntax specification	Report Generators
Re-engineering	Prototyping	Database Management
Risk Analysis Metrics	Translators	Query Processor
Query processor	Testing	
	Analyzers	
	Build	
	Macro processors	
	Fourth Generation Languages	
	Query processors	

Table 2: CASE Tool Categories

In Table 3, the percentages of organizations reporting their CASE tool adoption to be of the various general categories are shown. By far, the majority of the organizations are using development tools for their software development project.

Category of CASE Tool	Percentage of CASE Tools Adopted by Organizations
Technical tools	17.5%
Development tools	76.5%
Administrative tools	5.3%
Others	2.7%

Table 3: Level of CASE tool adoption

The questionnaire also addressed the nature of the use of CASE tools in organizations. These results are summarized in Table 4. The first item shown in Table 4 was used to confirm that the responding organization were, in fact, using CASE tool in their software development process. Twelve of the organizations (21.5%) said that they were not using CASE tools in their software development process.

To evaluate the benefit of using CASE tool in software development process, the respondents were asked to comment on the impact of the tool on productivity, quality, maturity of the organization and general satisfaction with the use of CASE tools from both practitioners and IT managers. Seventy percent (70%) of the organizations reported that CASE tool increases development productivity, while 83% reported that it improves the quality of the system developed. Overall satisfaction of software practitioners and IT managers showed an average satisfaction. This means that CASE tools bring about improvement to productivity and quality, but they are not uniformly accepted in the organizations.

Benefit of Using CASE tools	Agree (%)	Unsure (%)	Disagree ! (%)
One or more of CASE tools used in this firm	73.4	5.1	21.5
CASE tools should be used on all development activities	88.1	2.6	9.3
A single type of CASE is used for all IT projects.	48.5	36.4	15.1
CASE tool is adopted on a project-by-project basis.	43.2	39.4	17.4
Use of CASE tool increases productivity.	70.1	24.6	5.3
Use of CASE tool improves system quality.	83.0	15.0	2.0
Using CASE tool improves organizational maturity.	45.5	34.7	19.8
Software practitioner are satisfied with the use of CASH	43.5	36.8	19.7
IT managers are satisfied with the use of CASE looks.	48.5	15.1	36.4

Table 4: CASE Tool Usage

Key Informant Interview Results

Interviews were conducted with companies from a cross section of industries: three were software development companies and one a multinational oil-exploration company. CASH tool use and adoption in each of the companies is described below.

Case 1: Company A

Company A is a small software development company that develops software systems mainly for oil servicing companies in Nigeria. Both management and engineers are aware of the existence of CASE tools but only the software developers had first hand contact with use of CASE tools. The project manager, who. is also the Chief Executive of the company is of the opinion that the organization is “too small” to acquire and use CASE tools. This attitude explains the low level of use of CASE technology in this organization. Out of the five developers interviewed, only two feel that adoption and use of CASE tools will positively reduce cost and increase productivity.

Case 2: Company B

Company B is a large international software development organization that develops software systems for the Banking sector in Nigeria. The management of the company is interested in technical and administrative CASE tools since they believe that the software engineers are “paid to use their intellects” to create and maintain software systems. Developers use development tools acquired jointly to develop quality software systems and usually, they spend several overtime hours to acquire new skills. The success of the adoption and use of CASE tools by the engineers is via individual interest, team cooperation and discipline. Fifteen (15) developers interviewed use CASE, tools but the level of usage is low since they do not have mastery of some of the available tools due to their complex nature.

Case 3: Company C

The Company develops security systems for almost all sectors of the economy in Nigeria. They are into “custom” software development. It is a medium-sized software development organization. Management is interested in adoption of CASE tools and a little capital, though not sufficient is voted into “technology acquisition” in the budget. CASE tools adopted and used by this organization are acquired by management and it is the duty of the software developers to learn and use it without disrupting the normal work schedule. This may account also for the low level of adoption of CASE tools in this organization.

Case 4: Company D

This is a multinational oil exploration organization based in Nigeria with a whole department dedicated to software development. Huge amounts of money is usually voted for technology improvement and training. CASE tools are adopted and used by both management and software development staff. The use of CASE tools has improved the software development environment and as such this organization cannot imagine developing software without CASE technology. The

problems encountered (which were short-term) were with new programmers who had been used to traditional methods of software development and they viewed CASE as complex. Through training, team effort and effective communication, the engineers were able to gradually fit into the system. Most tool categories in table 2 are adopted and used by this organization.

Discussion

It was discovered from a series of informal interviews conducted among software developers and project/team leaders that the use and adoption of CASE technology is very low in Nigeria. However, successful use and adoption of CASE tools depends critically on planning, managing expectations, learning curve, management commitment, and change management amongst several other factors.

Software developers in the selected organizations are aware of the existence and the several benefits that can be accrued from the adoption and use of CASE. Most developers use application generators and documentation tools (which are both development tools) and management in most cases do not encourage the acquisition of such tools. From the management point of view, it is gross waste of resources to acquire CASE tools. It will increase the expenditure and thus add to the overall cost of software development. Thus, management does not usually consider long-term benefits. Also, it was discovered that training on tool usage is as a result of personal efforts of the individual developers. Management is more resistant to the adoption of CASE tools as we discovered than the users. This confirms the results of the responses obtained from our questionnaire where the level of use of development tools is 76.5% while administrative and other tools is just about 8%. We are tempted to conclude from the interviews that the common causes of low investment on adoption of CASE tools is as a result of a short-term "silver bullet" attitude on the part of management, resistance to new technologies by management, under capitalization, inability to share a vision at all levels of the organization to match methods and tools to the organization's current level of maturity.

Unlike the normal resistance expected from staff about learning new technology, it was discovered in our own case that the engineers/developers were excited and willing to learn on CASE tools across all phases of software development lifecycle, but management is more interested in the short-term economic benefits of these tools.

Conclusion

This study has provided initial information regarding the use and adoption of CASE tools. Whereas many organizations have a formal system development approach, in practice adherence to the use of CASE tool, does not seem to be enforced, and the extent of use varies. However, it was discovered that:

- a. Software organization without a defined software process may not benefit from the use of CASE tools for the technical and development activities.
- b. An organization has to consider the cost of acquisition of CASE tools and compare it with the overall budgeted cost of its software projects before considering adoption of implementation tools (Lower CASE and Upper CASE tools, workbenches, CASE environments).
- c. Management / technical staff have to be trained on the use of CASE tools hence adopting organizations must be willing to train staff on proper tool usage.

Although the impact of CASE tools on the software development is limited, a list of commonly cited benefits includes:

- Variable productivity gains
- Improved documentation
- Enhanced project communications
- Enforcement of project methodology and standards.

However, any decision to bring a CASE tool into an organization should be made with an awareness of both short-term and long-term implications of tool adoption. Also, for successful implementation of CASE, managers of software organizations should encourage their staff by providing adequate training, technical support and commitment. Efforts should be made in future by

stakeholders in both public and private sectors to evaluate their software projects constantly to see if they adhere to existing standards.

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