CASE Tools: Understanding the Reasons for Non-Use

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Abstract - Computer-Aided Software Engineering (CASE) technologies are tools that provide automated assistance for software

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tools is the reduction of the time and cost of software development and the enhancement of the

of the time and cost of software development and the enhancement of the quality of the systems developed [3,20]. Prior research into CASE tool

[redacted]

CASE tools (e.g., [8], [17]); (2) organizations abandon the use of the tools (e.g., [21], [24], [8]);

the 14 companies who had tried CASE, five had subsequently abandoned use of the tools. People within these fourteen companies believed that use of CASE tools improved documentation quality, improved analysis, and resulted in systems that were easier to test and maintain. However, they also found use of CASE tools difficult and time consuming. [17] in another cross organization survey, found that only 24% of companies were using CASE tools. In a follow-up survey of thirteen managers who had been using CASE tools two years earlier, [24] reported that continued CASE use could only be verified for four managers. The reasons for abandonment included cost, lack of measurable returns, and unrealistic expectations. [11] looked within organizations that used CASE tools and found that large numbers of their systems developers were not using CASE tools. He reported that in 57% of the organizations surveyed that were using CASE tools, less than 25% of the systems developers used the tools.

In the first research question, we are replicating these prior studies to see if similar results are found.

Research Question 2

What features of CASE tools are being used?

The term Computer-Aided Software Engineering (CASE) encompasses many different products with different functionalities. In the International Workshop on Computer-Aided Software Engineering (IWCASE) definition of CASE very broad terms are used: "...tools and methods to support an engineering approach to systems development at all stages of the process" [9]. When the term CASE is used, it is important to clarify what is being discussed. Most classifications of CASE tools start by considering later stages in the life cycle such as code generation and testing. Integrated CASE tools support both the early and later stages. Further classifications (e.g., [19]) usually list which functionalities are supported by the tool, such as data flow diagrams, entity relationships data models, etc. [10] provides a different type of model of CASE functionality which helps organize CASE tools. This model includes three functional dimensions of CASE tools: production technology, coordination technology, and organizational technology.

Production technology is the functionality that directly affects the capability of an individual to generate planning of design decisions and subsequent artifacts or products. An example of production technology is support for drawing a data flow diagram. [10] further divides production technology into representation functionality, analysis functionality, and transformation functionality. Representation functionality is the functionality that allows a system developer to define or describe an object, relationship, or process such as a data flow diagram. Analysis functionality is the functionality that allows a systems developer to experiment with alternate representations, models, or relationships, (e.g., testing consistency between a process model and a data model.) Transformation functionality is the functionality that executes a significant planning or design task, replacing or substituting for a human analyst, (e.g., generating executable code.) CASE tools may have any combination of these functionalities. Representation functionality is always present; the other two may or may not be present. This classification of functionalities has been used by researchers such as [2].

What is important about the classification in [10] is that it goes beyond the usual specification

Life Cycle
Object-oriented Approach
Rapid Applications Development (RAD)
Prototyping
Joint Applications Development (JAD)

In a pilot study, an "Other" category for methodology was included. Because, no single methodology was added more than once or twice, this list was used in the full study.

This research also explored the systems development activities that made up the systems development job. The job of a systems developer may contain requirements analysis, process design, data design, and programming among other activities [7]. But, not all systems developers do the same activities. One may spend most of his or her time on analysis; another, on design. This study captured the particular activities that each individual does. Systems developers were asked to indicate which activities were part of their job. The activities examined in this research were:

Systems Analysis (including feasibility studies and requirements definition)
Systems Design (including user interface, data, and process design)
Programming (or generating code)
Testing
Supervisory or other management tasks
Maintenance.

In a pilot study, an "Other" category for activities was included. Because no single activity was added more than once or twice, this list was used in the full study.

In the third research question, we see how the job of the systems developer changes with use of a CASE tool.

of behavior (the Theory of Planned Behavior) is widely used in social psychology and in IS research (e.g., [15], [16].) [5] introduced the Technology Acceptance Model, an adaptation of the Theory of Planned Behavior. The TAM model, which includes perceived usefulness and ease of use, has been found to predict intentions to use technology very well [15]. In an extension to TAM, [6] showed that there was an intrinsic motivation to use computers (enjoyment) as well as an extrinsic motivation (perceived usefulness). Enjoyment is defined as the degree to which an individual enjoys using the tool in its own right that is without regards to consequence [6]. Perceived usefulness is defined as the extent to which using the tool is perceived to improve performance of the job [6]. In [6], these two different types of motivation explained up to 75% of variance in intentions to use the tool. Using this model, if we find that CASE tools are fun to use and are perceived as useful, then we will find a group that is motivated to use CASE tools and intend to use the tools. Conversely, if people do not enjoy the tools and do not think they are useful, they will not be motivated to use the tools and will not intend to use them.

In the fourth research question, we explore these important motivators to explain intentions to use CASE tools.

METHODOLOGY

The research involved a cross-sectional field study of several organizations. Organizations were selected based upon two criteria: 1) the company needed to have systems development projects underway and 2) the company needed to be willing to cooperate with the researchers. Several companies in a large midwestern

Research Question 4

surveyed. Each company that did use CASE was asked if all systems developers using CASE could be surveyed. The companies either provided the researcher with a list of names of systems developers or handled distribution within the company themselves. Two questionnaires were used for data collection: one captured information about CASE tool use. In Table 1, job response rate is the percentage of individuals that received the survey about systems development and returned it. The CASE response rate is the percentage of individuals who were sent the CASE survey and returned it. No CASE surveys were sent to companies that did not use CASE Tools.

The data collection method was a written questionnaire. The steps suggested by [22] were followed to ensure a reliable and valid instrument. The initial questionnaires were developed based upon theory and prior research. The instruments were pre-tested to address content validity using experts in the field. A pilot test was conducted to measure construct validity and reliability. Multitrait-multimethod (MTMM) and factor analysis techniques were used to assess construct validity. Reliability was measured using

To increase the statistical power, we investigated whether the data from the pilot study could be included in the full study. None of the data items used in this project were changed between the pilot and the full study. All procedures were identical to those used in the main study. There was no overlap between populations. The only differences found between the pilot and full study were related to differences in organizations. Based upon this analysis, the pilot data were included in the analysis.

Table 2
Measurement of Enjoyment and Perceived Usefulness

Enjoyment	
1.	I find using this CASE tool to be enjoyable.
2.	I have fun using this CASE tool.
3.	The actual process of using this CASE tool is pleasant.
Perceived Usefulness	
1.	Using this CASE tool in my job enables me to accomplish tasks more quickly.
2.	Using this CASE tool improves my job performance.
3.	Using this CASE tool in my job increases my productivity.
4.	Using this CASE tool enhances my effectiveness on the job.
5.	Using this CASE tool makes it easier to do my job.
6.	I find this CASE tool useful in my job.

MEASUREMENT OF CONSTRUCTS

Representation, Analysis or Transformation Functionalities Used

The functionality questions were developed based upon [10]'s theory and tested in interviews with CASE experts. Because, representation functionality is always present with CASE tools, questions assessing its usage were not included. Use of analysis functionality was measured as the sum of the respondent's relative use of various features that [10] had defined as being analysis functions. Transformation functionality was measured in a similar manner. See Tables 4 and 5 for questions asked.

Enjoyment and Perceived Usefulness

Measures for Enjoyment and Perceived Usefulness (see Table 2) were taken from the already tested instrument developed in [6].

The Cronbach's alpha calculated for the enjoyment questions was .950. The Cronbach's alpha calculated for the perceived usefulness questions was .965.

Data were analyzed using regression techniques. The SAS statistical package was used for analysis.

DESCRIPTIVE STATISTICS

This section describes the sample. 233 people returned questionnaires. For demographic data characteristics, the sample size is slightly less than that as some people did not complete these fields. Table 1 summarizes the sample by company and CASE use.

Table 3 shows demographic statistics for the data. It was not assumed that the two populations would be identical demographically; however, the means and distributions were compared. For age, years in organization, and years in systems development, the means are statistically equal. However, the distribution of gender is not statistically identical. Higher percentages of males use CASE tools than do females. Additionally, the distribution of education is not statistically identical. CASE users were more highly educated.

Table 3
Demographic Statistics

Variable	Total Population[2]	Non Users of CASE	Users of CASE	Minimum	Maximum
Age	37.49 (8.21)	37.41 (8.50)	37.82 (6.96)	23	60
Years with Organization	5.58 (6.16)	5.35 (6.25)	6.53 (5.76)	0	31
Years in Systems Development	9.93 (6.52)	10.01 (6.77)	9.56 (5.45)	0	30

Variable	Total Population[3,4]	Non Users of CASE	Users of CASE
Gender			
Male	142 (68.9%)	109 (65.7%)	33 (82.5%)
Female	64 (31.1%)	57 (34.3%)	7 (17.5%)
Education			
High School	12 (5.8%)	12 (7.2%)	0 (0%)
Associate	38 (18.4%)	34 (20.5%)	4 (10%)
Bachelors	131 (63.6%)	105 (63.3%)	26 (65%)
Masters	24 (11.7%)	14 (8.4%)	10 (25%)
Doctorate	1 (.5%)	1 (.6%)	0 (0%)

RESULTS

Research Question 1

Are CASE Tools being used?

Our study found the same low use of CASE tools as reported in earlier studies. It was difficult to find companies using CASE tools. Even in the companies that use CASE tools, the amount of use is very low. Often managers have no idea how few people are using the CASE tools. For example, in one company that was not included in the study, a vice-president estimated that about 60 people in the systems development group were using the tool. However, a lower level manager much closer to the tool said that the real number was less than ten. This same pattern occurred in all the companies surveyed. In the four companies that use CASE tools (B, C, E, and G), surveys were sent to systems developers whom the company had identified as using CASE tools. Of those that responded to the survey, slightly more than 40 percent (35 out of 87) said that they did not use a CASE tool. (That percentage may be inflated since to indicate that you did not use a CASE tool, you simply had to fill in one field on the survey and return it. This could have resulted in higher response rates for non-CASE users.)

2 Counts and percentages.

3 Means and standard deviations.

4 Numbers do not sum to population totals because of missing data. Twenty-seven respondents did not provide demographic statistics either because they did not return the systems development survey form or because they left the demographic page blank. Another 4 people left age blank.

Research Question 2

What features of CASE tools are being used?

This research looked at two types of features:

[redacted]

those providing analysis functionality and those providing transformation functionality. Use of these features was low.

Very few respondents use the analysis functionality available in their tool. Analysis functionality was measured on a 1 to 5 scale, with 1 being "Never Used," 3 being "Sometimes Used," and 5 being "Always Used." The overall mean value for use of this functionality was 1.75. Less than 13% of the 48 CASE users who filled in this item (6 users total) said that they used Analysis functionality sometimes or more often (a level of 3 or more). Table 4 contains the details on the use of Analysis Functionality.

Table 4 contains each of the functionalities

seen in the table, only one of these functionalities had a mean use over 2.5 and that was providing documentation as a by-product of design. None of the items were indicated

used "sometimes" or more often than that (a level of 3 or more).

Research Question 3

Do people who use a CASE tool use the same methodologies that systems developers who do not use a CASE tool use?

Do people who use a CASE tool perform the same activities that systems developers who do not use a CASE tool perform?

Table 6 summarizes the systems development methodologies used by the sample of systems developers. Higher percentages of the CASE

Table 4
Summary of Analysis Functionality

Specific Functionality	Mean[5]	Standard Deviation
Tested for consistency between a process model and a data model?	1.98	1.60
Checked for the structural equivalence of objects or processes?	1.59	1.43
Checked for unnecessary or redundant model connections?	2.19	1.64
Detected inconsistencies in models, definitions, etc?	2.92	1.57
Identified the design impact of proposed changes in a design?	2.16	1.56
Searched the design for similar objects?	2.31	1.55
Used analytical decision aids to measure performance?	1.12	1.10
Detected and analyzed system errors from execution of a target system?	1.08	1.10
Searched design for complex relationships?	1.53	1.49
Suggested problem resolutions based on previously used solutions?	1.70	1.52

Research Question 4

Do systems developers who use CASE tools enjoy them?

Do they perceive CASE tools as being useful?

Systems developers who used CASE tools were relatively neutral about whether they were enjoyable or useful. Table 8 summarizes the results from the survey. The items were measured with the items in Table 2. The variables were measured on a scale of 1 to 7 where 4 was Neutral and 5 was Agree Slightly. The results of the items for each construct were averaged. As can be seen, the mean for both variables was between 4 and 5. This means that CASE users when asked their opinion of whether they agreed that using their CASE tool was enjoyable, on average they were between neutral and agree slightly. And perhaps even more telling, when asked whether they agreed that using the CASE tool was useful on the job, on average they were between neutral and agree slightly.

Table 6
Systems Development Methodology Used

Methodologies Used[6]	Total Population[7]	Non Users of CASE	Users of CASE
Life Cycle	126 (60%)	95 (55.9%)	31 (77.5%)
Object-oriented Approach	61 (29%)	49 (28.8%)	12 (30%)
Rapid Applications Development (RAD)	57 (27.1%)	37 (21.1%)	20 (50%)
Prototyping	100 (47.6%)	75 (44.1%)	25 (62.5%)
Joint Applications Development (JAD)	79 (37.6%)	55 (32.4%)	24 (60%)

Table 7
Percentage of Time Spent Doing Various Tasks

Time Spent on	Total Population[8]	Non Users of CASE	Users of CASE
Systems Analysis	14.72 (18.13)	11.54 (12.20)	28.00 (29.63)
Systems Design	17.13 (14.16)	16.78 (13.64)	18.60 (16.28)
Programming	19.82 (17.81)	21.82 (18.25)	11.45 (13.01)
Testing	15.32 (13.51)	16.68 (13.64)	9.62 (11.62)
Supervising	13.97 (24.53)	13.70 (24.36)	15.10 (15.28)
Maintenance	13.39 (18.02)	14.75 (18.39)	7.7 (15.28)

6 Respondents could indicate that they used more than one methodology.

7 Counts and percentages

8 Means and standard deviations

Table 8
Enjoyment and Perceived Usefulness of Case Tools

Variable	Mean	Standard Deviation	N
Enjoyment	4.49	1.47	52
Perceived Usefulness	4.80	1.56	52

DISCUSSION

This study provides interesting additional insight into how CASE tools are actually being used in business. We replicated prior research that shows low use of CASE tools. It was difficult to find companies that use CASE tools. Within the companies that are using CASE, not many of the systems developers actually use the tool. Interestingly, this low use was not well communicated within the companies. High level managers greatly overestimated what percentage of their systems developers uses the tool. Even managers close to the tool overestimated the numbers of users. When these managers identified the people that they were sure were using CASE tools, about 40% of those who returned the surveys actually were not using the tools. It is easy to speculate why systems developers and lower level managers are not sharing this low use with higher level managers. They are aware of the high cost of a CASE tool (estimated to be $22,000 per person including software, hardware, and training [21].) Publicizing this questionable investment might be unpleasant.

We further dissected CASE tool usage in this study. Few of the advanced features within the

What explains this low use of the CASE tools? This study suggests two possible reasons. First, the job that systems developers do is not the same when a CASE tool is used. Systems developers using a CASE tool are more likely to be using a formal methodology than those who do not use a CASE tool. And the way systems developers spend their time when using CASE tools is different then the way systems developers who do not use CASE tools spend their time. More than twice as much time is spent in systems analysis. One CASE tool user commented that it seemed as if they never ended the requirements determination stage when they used CASE tools. This implies that the job is much more formal with CASE tools. Prior research has shown that systems developers prefer jobs that have high autonomy [13], [4]. This increased formality of the job may not be received well by systems developers who have a strong desire for autonomy.

Secondly, systems developers do not appear greatly motivated to use the tools. Neither intrinsic motivation (the tool is fun to use) nor extrinsic motivation (the tool is perceived to be useful) is high. [6] found that these two motivations explain up to 75% of the variance in

questions about systems development methodology and activities. This reduces the method bias that is implicit in using a single data collection method as it makes it less likely that answering questions about the job influences answers to questions about the CASE tool. The survey was done in an organizational setting, which increases external validity and makes it more likely that the results are generalizable. However, this study also has some limitations. First, all respondents were chosen from a single metropolitan area and from companies that were willing to cooperate with the researchers. This may not be a representative sample. Additionally, the CASE sample size is low and reflects only a few CASE tools. That increases the chance that the results might not be representative. Despite these limitations, the findings contain useful ideas for those who manage the systems development function.

IMPLICATIONS FOR ORGANIZATIONS

What then can an organization do to attain the expected high productivity benefits associated with CASE tools? Obviously these benefits cannot be achieved without increasing use of the tools. More usage may be attainable through incentives. However, this study shows that systems developers are fairly neutral about the usefulness of CASE tools. A manager could increase the perception of usefulness by training and reinforcement. This training should include concrete examples of how the CASE tool produced beneficial results for the systems developers themselves. Apparently the postulated benefits to the organization are not, in themselves, sufficient to motivate use.

This study suggests that the best way to choose a CASE tools is not based upon how many advanced features the tool has. This is often used in the selection criteria but this study shows that few of the advanced features are actually used in organizations. Instead a selection method that considers whether the tool is enjoyable and so one that people will be internally motivated to use, would be more likely to allow the organization to reap the benefits that come with CASE tools.

Finally, as has been suggested in other studies (e.g., [2] and [14],) resistance to CASE tools may in part be based upon resistance to methodologies. CASE tool imposes a methodology on systems developers who want jobs with high autonomy. Choosing a tool that matches the organization's current methodology would help in acceptance. If no methodology is in place, the successful implementation of a CASE tool may first depend upon a successful selection and implementation of the methodology.

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