Promotion and Adoption of CASE Technology

—Four Cases in Taiwan

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Abstract

CASE tools are not widely accepted and used by IS developers in Taiwan, hence this paper intends to find out the latent problems that exist behind the scenes. Four cases are selected, including two CASE tool suppliers, and two user organizations. It is expected that we can have a deeper understanding regarding the low usage and hence provide some meaningful suggestions to those attempting to adopt CASE tools.

According to the cases and data gathered, suggestions to both suppliers and users are proposed. First, although effective communication with users and efficient project management are critical factors for traditional systems development, they should also be in place when CASE is implemented. Second, integrative development tools can help improve the performance of project teams when used together with suitable methodologies. Third, software development environment is not only a technical issue, but also an organizational challenge. Top management support and user involvement are strongly recommended. Fourth, interaction between users and suppliers should be viewed from both technical and social perspectives.

Keywords: CASE (Computer-Aided Software Engineering), Information Systems Development, Promotion and Adoption.

1. Introduction

It is evident that hardware products in the market grow at a fast speed, while software products grow relatively slower. Among those tools that aid in information systems development, there are CASE (Computer-Aided Software Engineering) tools, which have been repeatedly discussed in past literature. Broadly defined, CASE tools include those processes, methodologies, techniques, and tools that aid in software development utilizing information technology.

Although it is believed to bring improvements in systems development activities, the adoption rate of CASE technologies continues to be low among information systems departments[Rai and Patnayakuni, 1996]. It is the same with companies in Taiwan. It then becomes interesting to see why such believed-to-be-useful tools are usually ignored by most systems developers.

With a few exceptions, earlier research on CASE adoption has mainly been descriptive without offering theoretical orientation or attempting to explain factors affecting the adoption [Iivari, 1996]. Rai and Patnayakuni[1996], however, try to empirically test a theoretical model from the viewpoint incorporating both need pull and technology push factors. The research of Iivari[1996] draw from the innovation diffusion/adoption theory as a reference theory that applies to information systems implementation and CASE adoption. With these researches in mind, this paper intends to find out the latent problems that exist behind the scenes using case studies, in the hope that we can have a deeper understanding of the problem. Four cases are selected, including two CASE tool suppliers, and two user organizations. Besides having a deeper understanding regarding the low usage, it is also expected to provide some meaningful suggestions to those attempting to adopt CASE tools.

2. Literature Review

2.1 Critical Factors and Experiences in Implementing CASE

As stated by Forte and Norman[1992], success with CASE depends critically on planning, managing expectations and early experiences with the technology. Common

causes of failure include a short-term, “silver-bullet” attitude on the part of management, inadequate infrastructure, undercapitalization, inability to share a vision at all levels of the organization, and failure to match methods and tools to the organization’s current level of maturity. Danziger and Haynes[1989] further points out that managing the CASE environment needs a framework of management. Incorporated in the framework include upfront and continuous planning, dealing with changes required, impact on the staffing function, structure and capability to support the management function of directing, control, and open communication for managing expectations of both upper-management and staff.

Firms that have tried CASE tools and failed often criticize the tools on several dimensions, including their expense, processing platforms that require above-average power and capacity, and tools that are complex both in terms of use and of support [Senn and Wynekoop, 1995]. According to the cases studied, Senn and Wynekoop propose nine practices that differentiate successful implementations of CASE tools from failed ones:

1) Creating informed awareness.
2) Providing meaningful communication with developers.
3) Conducting meaningful, retainable training.
4) Creating realistic expectations.
5) Ensuring meaningful CIO support.
6) Developing suitable infrastructure.
7) Determining evaluation criteria in advance.
8) Recognizing value of CASE subset.
9) Making needed investment.

2.2 Resistance of Managers and Engineers

Norman et al.[1989] argue that implementing CASE is not simply a matter of providing better tools, but the more complex problem of introducing organizational change. They also propose five propositions:

1) CASE implementation is a technological change that affects the task, structure and people subsystems within the organization.

2) Resistance to change is expected from the users of CASE and cannot be overcome unless the forces in favor outweigh the restraining forces of CASE.

3) In order for planned change to be successful, five key elements (such as training, user involvement in the selection process, trust, open communication, and management's commitment) are needed in the environment.

4) Experienced workers resist CASE more than younger or inexperience workers.

5) Success of CASE implementation is more likely to occur when both users and management have similar perceptions and acceptance of the implementation strategy used.

The successful implementation of CASE is not only a technical issue but also a people issue. It is essential that information systems managers realize that their staffs often have a strong resistance to change, especially when it comes to learning to use a new tool. Before beginning a CASE implementation, managers must ensure that the proper training program, technical support, and commitment are in place [Zagorshy, 1990]. However, due to the difficulty in quantifying the economic benefits of these tools, a longer period of time may be needed for the substantiation of the benefits, which may also cause resistance of management groups.

2.3 Evaluation in Choosing CASE Tools

CASE technologies involve significant automation of the software development life cycle. Currently available tools fall into three categories: lower CASE, upper CASE, and integrated CASE. Lower CASE provides support for the later life cycle stages, especially code construction and testing. Upper CASE offers assistance during the early life cycle stages of analysis and design. Integrated CASE tools, by contrast, support both the earlier and later stages of the life cycle [Banker and Kauffman, 1991].

Using an evaluation instrument including the four dimensions of structural analysis, entity-relationship modeling, structral design, and logical data design, Vessey et al.[1992] conducted an analysis of 12 commercially available CASE tools during the

summer of 1989. Vessey et al. suggest that when choosing a CASE tool, an organization must balance the demands of a tool's functionality, support for methodology and team interaction, and technical knowledge requirements.

Huff[1992] indicates that preparing a comprehensive CASE budget framework is one critical step toward successful adoption. He further states that the vendor's price of a CASE tool is like an iceberg, which represents only a small portion of the true adoption cost of CASE.

To compensate the lack of organizational issues in CASE studies, Orlikowski[1993] develops the framework shown in figure 1 to conceptualize organizational issues in CASE adoption and implementation. It should be emphasized for and noticed by managers that it is not only about a new technology, but the change process of the whole organization.

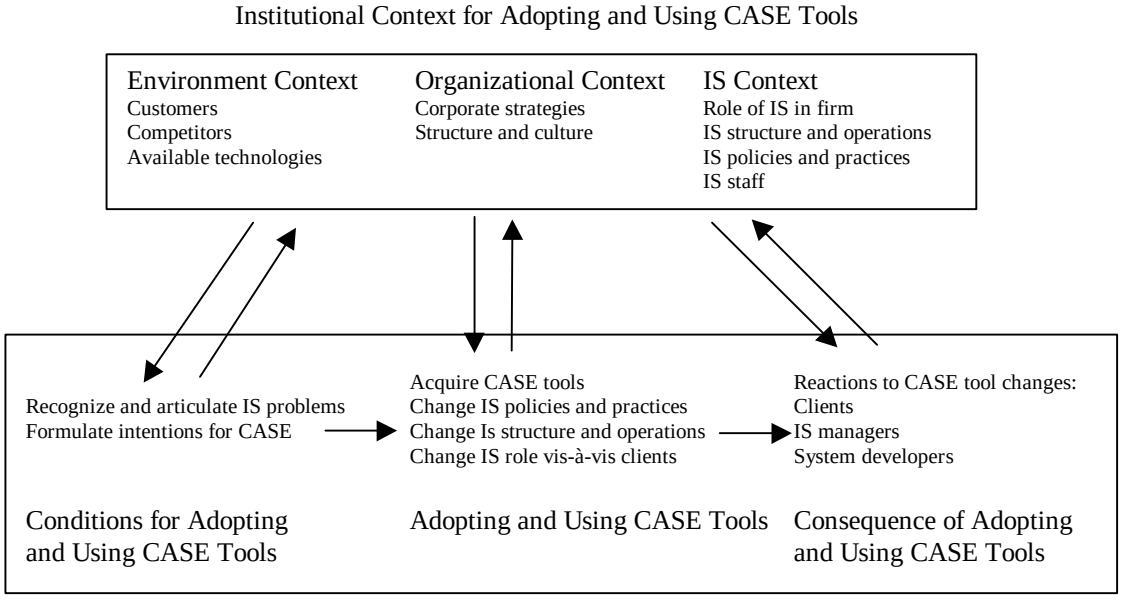

Figure 1. Process of Organizational Change Around CASE Tools
Source: Orlikowski[1993]

Rai and Howard[1994] also conducted an empirical study with regard to organizational issues, and a synthesis of past research in information systems implementation and organizational innovation reveals the factors that relate to propagation of CASE tool usage in information systems departments. They can be categorized as: organizational environment, user characteristics, organizational processes, organizational structure, and task characteristics.

2.4 Evaluation of Performances of CASE Tools

Many IT professionals have gravitated toward CASE tools in search of five principal benefits: improved development productivity, enhanced software quality, easier maintenance, uniformity across applications, and integration of data and processing across applications [Senn and Wynekoop, 1995]. However, past research show divergent perspectives on CASE tools benefits. Although some of them show that CASE tools may improve productivity [Banker and Kauffman, 1991; Norman and Nunamaker, 1988], others indicate that these benefits are hard to estimate [Card et al., 1987]—suitable training and experiences are needed; resistance of developers occur; time needed for design and test are longer [Norman et al., 1989; Vessey et al., 1992].

Finlay and Mitchell[1994] compare changes in productivity and information systems quality consequent on the CASE introduction. Questionnaires are also used to determine the perceptions of both developers and their customers to the new methodology and tools. The investigation into human resource, technical, and managerial infrastructure issues gives us a clearer view of CASE introduction and implementation.

Deloitte & Touche poll more than 2,200 private sector information systems departments to explore these topics and others, with 568 of them responding to the survey. Specially, CIOs were asked to assess the use and impact of CASE tools in their organizations, which yielded two particularly compelling conclusions: First, CASE tools do not necessarily lead to systems development productivity improvements. Second, CIOs suggest that barriers to the implementation of CASE tools are considerable—both in terms of the level of investment required and in the logistics of managing effective CASE implementation [Hayley and Lyman, 1990]

3. Research Framework

After the intensive review of past literature and considering the low usage of CASE tools in Taiwan, the authors decide to proceed with case studies. To maintain a balanced perspective, totally four suppliers (companies A and B) and users (companies C and D) of CASE tools are selected. For each case selected, interviews are to be conducted, and related secondary data also gathered to be supplementary to the interviews.

Research framework in figure 2 shows the four perspectives, *organizational characteristics*, *usage characteristics*, *user characteristics*, and *technological characteristics*, that are to be discussed by the authors in this paper. Analyses from the cases are expected to give us a clearer understanding and hints as to how we can promote the usage of CASE tools in Taiwan.

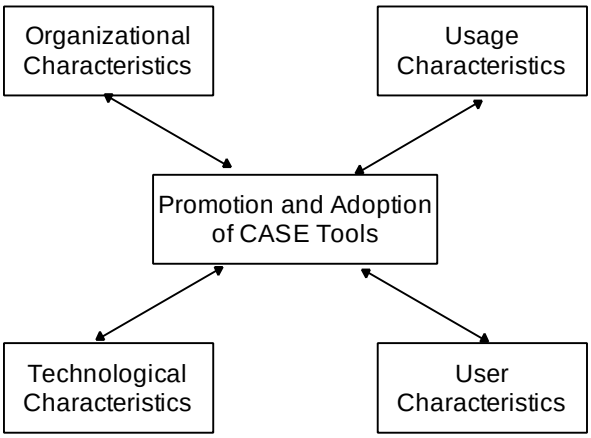

Figure 2. Research Framework

4. Case Study

Case 1: Company A

Company A is a large-scale CASE tool supplier in Taiwan. The tool that A provides is called *Silverrun*. Silverrun has three components. The first component has an expert system built-in and aids in building ERDs (entity-relationship diagrams). The

second component aids in generating DFDs (data flow diagrams) for systems developers. The third one builds database definitions. Silverrun is characterized by providing consistent user interfaces in these three components.

The primary products A provides are Upper CASE tools; Lower CASE tools are still under development. Supported systems development life cycle stages are from requirement analyses to data definition languages, and data-oriented methodologies are utilized. With regard to management support of the tools, the decisions are always made by CIOs, unless senior managers have strong information technology senses.

When Silverrun is to be implemented, the learning time needed is usually not too long; experiences in structural analyses are required, however. It is also found that experienced programmers generally show lower acceptance than new programmers. It may be due to lack of experiences that new programmers are willing to pay efforts to learn new tools. Besides that, project coordination and management are also found to be important when dealing with user resistance to using the tool.

Project performance is evaluated by time needed for completion. However, due to the learning time needed for the first time of usage, the first project usually takes more time for learning and coordination efforts, and impatient managers may call a halt of the project at this stage. According to the interviewees, the effectiveness of CASE tools are usually more obvious in larger-scale projects with 100 participants or more. When speaking of satisfaction, individuals may adopt CASE tools because of the desire to learn newer tools or methods in developing systems. However, it requires the commitment from senior managers and organizational cultures to help build a tradition of using the tools in project teams. Standardized procedure may also be required thereafter, which most organizations lacks in.

Case 2: Company B

Company B is a non-profit organization, which is responsible for the progress and development of the software industry in Taiwan. The CASE tool developed by B is called *Wan-Jun*, which is sold at the price of about US$30,000. Products provided by B are primary Integrated CASE tools, supporting from requirement analyses to code generation stages in systems development life cycle. Some may argue that the price of Wan-Jun is

too expensive. However, why the much higher prices of DBMS software are considered reasonable? As indicated by B, the point is whether there are strong evidence to prove the effectiveness of the tools.

It is not too hard to learn the use of the tools, but the tradition of using them may be harder to be maintained. Fad still plays an important role in tool selection. The popularity of graphical software and such tools like Visual Basic, Delphi, and PowerBuilder make systems development easier. Diagrams like DFD can also be easily built with these tools, which degrades the importance of CASE tools in systems development. However, gains in implementing CASE in systems development is still hard to measure, stated by interviewees of B.

Case 3: Company C

Company C is a military department, and is in charge of military information management tasks. Both Upper CASE and Lower CASE tools are utilized, supporting the stages from requirement analyses to data definition languages, building related documents, and database table generation. Data-oriented methodologies are the followed.

Budgets for purchasing software tools are not planned in advance in C. Staffs propose for procurement when there is necessity. Budgets allocated depend on the functions of the tools. Generally speaking, if the tool is aimed at generating documents, then US$10,000 to $20,000 will be allocated. However, if the tool provides the function of code generation, then the budget will be raised accordingly. Persons in charge in C are also supportive of using CASE tools. To illustrate the importance of using the tools and keeping up with newer technologies, they even demonstrate using the tools themselves. It surely gives pressure to their subordinates.

Experiences from C show that when CASE tools are implemented, those who have experiences in structural analyses and database designs learn faster than those that do not. Usually one or two days are needed for those experienced. However, it does not take too long for those inexperienced because of the strict training programs and discussions with peer workers. The interviewee also states that the most annoying problems faced are the chaos caused by quick and incomplete works. That is usually because of the pressure of deadlines and Chinese characteristics. Usually managers have

to coerce the workers to follow the rules to maintain the tradition and ensure the quality of the projects.

Because of the commitment and attentions paid by top managers, CASE tools are thus valued important for systems development in D, and hence resistance of workers is rare. However, an integrated tool is still needed. C currently uses PowerBuilder as the client tool, together with Silverrun and ER-Win. Silverrun primarily aims at documents generation; ER-Win at database table creation and ensuring the consistency between documents and data. As stated by the interviewee, a code generator is needed to raise their productivity. Generally speaking, however, workers in C hold high senses of achievement and positive attitudes toward their work, for being able to use state-of-the-art tools.

Case 4: Company D

Company D is also a non-profit organization, which is a leading R&D organization in the telecommunication industry. D uses both *HP Teamwork* and *HP Softbeuch*. The former works from requirement analyses to ERD (entity-relationship diagrams) generation, while the latter helps in debugging. From the stages of design to code generation, CASE tools are not used, however.

Incentives for D to implementing CASE tools are: (1)recommendation by suppliers; (2)to train workers to utilize newer technologies; (3)to raise productivity in systems development; (4)to ensure consistency between projects; and (5)to ensure project quality. Managers support the implementation because it provides workers with alternatives to older tools. However, workers are not forced to use them. The premise is still to complete the projects on time. Generally speaking, research departments in D are more interested in learning newer tools or technologies, and are more willing to promote them. However, when it conflicts with the completion of projects, the latter is always given higher priority. With regard to usage characteristics, inexperienced users need to spend only about a week to learn to use the tools. It is obvious that the tools are not too hard for the workers. What is more important then is whether the workers are willing to use them.

Currently there are about thirty people in a project team. Four or five among them use HP Teamwork for front-end requirement analyses. The rest of the team do not have suitable tools for use because there are no corresponding tools in aiding their works. Because of time pressure, only a short period of time for design and code generation is left when requirement analysis stage is completed. Limited time hinders the team from trying new tools. The project has been finished for about six months. However, viewing it retrospectively, it is found that data seem to be inconsistent because of tight timing control of the project. D therefore decides to adopt *RATIONAL*, which has a wider range of applicability. D expects it can assist until the code generation stage of systems development life cycle in order to further improve the productivity of their project teams.

5. Discussions

As stated by Sumner[1995], factors that help in successfully adopting CASE tools include both internal and external integration strategies. Internal integration strategies relate to the software development environment, compatibility of current technologies, and other inner-organizational supportive factors. External integration strategies, however, relate to user involvement in information systems development, user responsibilities in project management, and alignment of information systems and business strategies. To be precise, internal integration strategies include (1)compatibility: whether innovations are consistent with existing systems and past adoption experiences; (2)maturity of the process: process maturity model may be utilized to evaluate systems development processes; (3)supportive factors: whether supports are available from opinion leaders, suppliers, senior managers, and users. External integration strategies include (1)integration: cooperation between information systems professionals and business managers; (2)alignment: alignment of information systems and business strategies; (3)effective communication with users; and (4)user involvement and responsibilities in project management.

As depicted by the cases, it is found that basically both suppliers and users endorse the idea that internal integration strategies should align with external integration

strategies. Referring to figure 2, we can further explain this viewpoint with respect to the four perspectives:

1) *Organizational characteristics*: strong and long-lasting support and commitment from senior managers are important in ensuring the performance of the CASE tools.

2) *Usage characteristics*: when methodologies, especially structural methodologies, are used together with the tools, performances of workers may be raised accordingly.

3) *User characteristics*: it should be dealt carefully to avoid user resistance and intensify experiences of successful adoption of new tools.

4) *Technological characteristics*: continual search for newer technologies makes information systems developers keep up with the tide of the global environment, especially when time pressure or competitive advantage is of critical importance.

However, three points should be further emphasized. First, organizations need to develop an effective evaluation policy so that managers may accurately estimate how well the CASE tools are implemented in their organizations. Second, close contact and cooperation with suppliers may aid in success, especially when suppliers can offer technical supports when necessary. Third, technical maturity of users may also affect the performance of CASE tools implemented.

According to the cases and data gathered, suppliers and users are suggested. First, although effective communication with users and efficient project management are critical factors for traditional systems development, they should also be in place when CASE is implemented. Second, integrative development tools can help improve the performance of project teams when used together with suitable methodologies. Third, software development environment is not only a technical issue, but also an organizational challenge. Top management support and user involvement are strongly recommended. Fourth, interaction between users and suppliers should be viewed from technical and social perspectives. The former includes the implementation of proper tools, operation standards, and physical working conditions; the latter refers to the interaction and collaboration of users and suppliers. Since the goal of information

systems is to improve users' working environments and competitive positions in the market, both technical and social issues should be noticed to gain expected outcomes.

6. Conclusions

Resistance of users is an important factor for CASE promotion and adoption. Managers are suggested to build an environment with open communication and psychological consultancy for information systems developers if necessary. Besides human issues, ease of use of CASE tools is also important. A good CASE tool should require short learning time for users so as to shorten time needed for project completion and should aid in improving both systems quality and project team productivity. With regard to decision makers, budgets should be well-planned; both software procurement and user training should be given the same importance

It is also suggested to implement pilot systems before the real system is actually adopted. Projects selected are suggested to be those with less time pressure. Experiences in these projects can be adopted by other projects to increase the probability of success. Evaluation of performances of these projects should be done in a long-term way, with proper standards set in advance. Groupware, however, may be considered to be adopted together with CASE tools, to be supplementary to the teamwork of project teams. None of the four cases in this paper mention the usage of groupware, but that may be beneficial in the long term.

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