

# From CAATTs Adoption to Continuous Auditing Systems Implementation: An Analysis Based on Organizational Routines Theories

Chia-Ming Sun

*Department of Accounting, Yunlin University of Science and Technology*

**ABSTRACT:** *Previous studies on the use of computer assisted auditing technology and techniques (CAATTs) mostly focus on computer skills and perceived usefulness of auditors, and the influential factors from organizational environments; however, they seldom emphasize the group level. In this research, we study the technological adaptation process of a case company, which continuously implemented four CAATTs projects in three years. We summarized and analyzed the routinization process of how the case company adapted their computer-aided audit procedures from an experimental action to daily usage. An approach based on organizational routines theories was adopted to study group learning and interactions among project members, and to understand how they integrated automated auditing techniques and mechanisms into the existing manual auditing procedures. The process also reveals the incremental progress of an emerging routine from CAATTs adoption to continuous auditing systems.*

*The research results show that the documentation of CAATTs projects and group learning among different functions contribute to the routinization of automated auditing procedures; the continuous auditing system based on the automated auditing program also contributes to routinely audited tasks. However, the improvisational nature of auditing activities, implicit characteristics within general auditing software, and rigidity of automatic auditing programs cause the resistance of auditors on CAATTs use, and also impede the emergence and flexibility of computer-aided auditing procedures.*

**KEYWORDS:** *CAATTs, Continuous Auditing, Information System Control, Technological Adaptation, Organizational Routines.*

## 1. Motivation

The popularity of information technology in organizations, driven by the force of the global competitive information technology market, has created the era of automated auditing techniques (Bhimani, 1996; Elliott, 2002; Zhao, Yen & Chang, 2004). It has been commonly accepted by scholars and practitioners that the use of computer assisted auditing techniques (CAATTs) can reduce auditing costs and improve efficiency, and also help auditors to focus on high-risk business activities (Braun & Davis, 2003; Debreceny

et al., 2005). However, Alles, Kogan and Vasarhelyi (2009) propose that the inadequate understanding of the nature of audit automation techniques is the greatest obstacle for organizations in adopting CAATs.

Automated auditing techniques can be roughly classified as computer-assisted auditing techniques (CAATs). They are widely adopted by accounting firms and internal auditing departments and are emerging auditing techniques in continuous auditing. Computer-assisted auditing techniques are the tools and techniques which are used to assist auditing. Mostly, they include tools and techniques to audit computer application, and the software to extract and analyze data (Braun & Davis, 2003). As many organizations use sophisticated information technology to assist business activities and to improve information processing efficiency (Ramamoorti & Weidenmier, 2004), how auditors effectively use CAATs to review and monitor the effectiveness of internal control systems has become an important research issue (Braun & Davis, 2003; Gehrke & Wolf, 2010; Lindow & Race, 2002).

Scholars and practitioners have high expectations on the emerging assurance service based on continuous auditing techniques. Continuous auditing is defined as a type of auditing that produces auditing results simultaneously with, or a short period of time after, the occurrence of relevant events (Alles et al., 2006; Kogan, Sudit & Vasarhelyi, 1999; Rezaee, Elam & Sharbatoghlie, 2001; Vasarhelyi, 2002). Because continuous auditing is implemented as a fully automated process on a computer application, it will save auditors substantial costs when verifying a large volume of transaction data. Due to continuous auditing techniques adopting a more immediate approach to execute control testing and risk estimation, they are believed to enhance the quality of auditing evidences. If supported by an artificial intelligence analysis tool in the verification procedure, they will also enhance the efficiency of auditing staff, and improve the quality of audit reports (Elliott & Jacobson, 1997).

However, continuous auditing is not, as Alles, Kogan and Vasarhelyi (2002) expected it to be, highly respected by external auditors -- internal auditors have become the main promoters of continuous auditing techniques. For the United States, accounting firms focused on the activities derived from Sarbanes-Oxley Act Section 404 and lost interest in the development of continuous auditing; also, section 201 requests strong independence for external auditors, so it is argued: will the new continuous assurance service influence the independence of external auditors? In contrast, internal auditors are eager to find resources to cope with the new responsibilities conferred on them by Section 404 (Chang, Wu & Chang, 2008); thus, in promoting the project on continuous auditing, they will not be restricted by independence requirements (Alles, Kogan & Vasarhelyi, 2008).

However, in the IIA's "2009 IT Audit Benchmarking Study" report, only about a quarter of organizations who have adopted CAATTs use continuous auditing techniques; and although many organizations have tried to use CAATTs, most organizations still consider the use of CAATTs to be associated with high cost, implementation difficulties, and low short-term benefits. As a result, less than 50% of organizations use computer assisted auditing software for fraud detection and prevention (The Institute of Internal Auditors, 2009).

Previous studies mostly focused on the characteristics of auditors as well as the design of CAATTs software to analyze the difficulties within CAATTs adoption (Huang, Hung & Tsao, 2008; Janvrin, Lowe & Bierstaker, 2008; Mahzan & Lymer, 2010). However, in addition to the computer skills of auditors and CAATTs software training, some scholars pointed out that perhaps the more fundamental problem is that people underestimate the impacts of automated auditing on auditing procedures and standards? Also, promotions of continuous auditing usually emphasize the "redesign" of existing auditing procedures, causing continuous auditing to be an unrealistic application having few impacts on current auditing procedures and methods. **Therefore, the incremental evolution process, which extends and integrates traditional auditing procedures with the experimental usage of CAATTs, might contribute to the adoption and development of continuous auditing.**

As a result, Alles et al. (2009) state that dramatically reengineering existing audit procedures is not feasible. They suggest that the continuous usage of CAATTs might help explore how to adopt continuous auditing techniques. Therefore, continuous auditing techniques are not new technologies to replace CAATTs, but rather as extensions of CAATTs. To explore how to adopt continuous auditing techniques, scholars and practitioners might start from the study of CAATTs usage and consider how to integrate them with the daily activities of auditors.

The issues mentioned above are the motivations for why we focus not only on the skills of auditors but also auditing activities which include computer auditing procedures. We consider the continuous use of CAATTs as evolutionary organizational routines, which start from the initial adoption of CAATTs and result in the transformation of traditional auditing. Therefore, the scope of this study covers the activities of CAATTs project groups, which contain the auditors, the chief of auditing executives, Information Systems (IS) staff, and IS managers. In addition, the theoretical framework mainly focuses on the evolutionary process of auditing practices, not only on the organizational characteristics of leadership style, supports from managers, and others discussed in previous studies.

In other words, we consider auditing activities as a kind of organizational routine, which will help us predict and analyze the patterns of organizational activities. Since

the formation and evolution of organizational routines involves the learning process of organizations, the analysis of auditing practices will help us to understand how the usage of CAATTs becomes a part of daily activities and becomes the opportunity to change existing auditing procedures.

In summary, this study examines the interactions and group learning among CAATTs project members which are concerned with automating the traditionally manual procedures of auditing through integration with CAATTs. We examine how they start from the trial usage of CAATTs, and then proceed with experiments on continuous auditing and monitoring and finally work with CAATTs as emerging routines in auditing practices.

## **2. Literature**

### *2.1 Current status and challenges of CAATTs*

In the modern business environment, auditors use computer-assisted audit techniques (CAATTs) to assist their tasks of reducing audit risks and cost (Braun & Davis, 2003). Among the computer-assisted auditing techniques, General Audit Software (GAS) is easy to operate and can fit for different users and environments, therefore it has become the most widely used of CAATTs tools (Braun & Davis, 2003). GAS has many advantages, including ease of use, a huge data processing capability, a read-only aspect (it does not change raw data), the ability to import data presented in various way, and provisions of required auditing functions such as statistics, sampling, audit trails and so on. Despite this, GAS is still not widely applied in Taiwan, by private auditors and companies. For example, in the investigation of internal auditors in Taiwan, Huang et al. (2008) found that only 23.7% of organizations adopt GAS.

Lanza (2005) summarized the difficulties in using CAATTs and explained why CAATTs is still unpopular among auditors. The time spend for data acquisition and conversion almost equals to the time spend by the auditor in field audits. Secondly, when information systems change, the automated auditing programs have to be changed as well. Also, it is very difficult to obtain electronic data when there is a lack of support from IS staff. Finally, it is a time-consuming task for auditors to write automated auditing programs.

Many studies have explored the personal factors influencing auditor's adoption of CAATTs. Huang et al. (2008), for example, adopted the Technology Acceptance Behavior Model (TAM) (Davis, Bagozzi & Warshaw, 1989) to investigate the personal factors impacting on an internal auditor's use of CAATTs. The factors mainly consist of "perceived usefulness" and "perceived ease of use." The IT skills of auditors have also

been recognized as critical factors affecting adoption. Many scholars and practitioners advocate that auditors become familiar with CAATs (Burnett, 2003; Gallegos & Looho, 2000; Lord, 2004). Debreceny et al. (2005) and Ramamoorti and Weidenmier (2004) state that auditors with sufficient IT skills will significantly improve effectiveness of auditing while reducing the dependence on IT staff.

From the literature, we find that, while some scholars emphasize the ease use of GAS and the benefits of using CAATs, others emphasize the importance of IS staff involvement and the IT skills of auditors. Therefore, the implementation of CAATs requires the involvement of auditors and professionals in different fields, such as systems analysts, database managers, application software vendors, and others (Rezaee et al., 2001).

In summary, perhaps the difficulties of promoting CAATs relate to how professionals from different areas can be combined to learn from each other and work together, which involves cross-section collaboration and integration of different fields of organizational practices. Therefore, the implementation of CAATs could be considered as an adaptive organizational that involves interaction among project members which modify existing organizational routines (original auditing procedures) and becomes the new organizational routines (combining previous auditing procedures with automated auditing procedures).

## *2.2 Technological adaptation, organizational routines and improvisation activities*

Many scholars have explored the use of adaptation process technology, such as Rice and Rogers (1980), who indicated that with the continuous use of technology users will discover and reinvent the application and usage of the same technology. They suggest that these adaptation activities should be considered as part of the innovation process, and that these activities are important for users in improving their satisfaction (Johnson & Rice, 1987). Tyre and Orlikowski (1994) referred to these related adaptation activities as “technology adaptation,” and defined them as “the modification and changes of technology usage after adoption,” which involves the characteristics of technology, operation activities among users and the change of assumptions, knowledge and experiences. These changes may mainly come from user involvement or the interactions between users and developers.

The technological adaptation approach emphasizes the importance of follow-up modification after the adoption of technology, which will assist the effective use of technology and improve operational efficiency (Dutton & Thomas, 1984). The adaptation process is not only about affecting the usage of technology but also to changing the organizational structure and work practices (Van de Ven, 1986). Tyre and Orlikowski

(1994) also indicate that the longitudinal view of the technological adaptation process may differ with a cross-sectional view. Because the experiences through established practice will simplify the decision-making process, by focusing on new information while ignoring other parts, individuals will ignore misfit problems in their usages of the technology and over time these problems be integrated into the organizational process and evolve as organizational routines.

Kwon and Zmud (1987), based on the Change Model of Lewin (1952) proposed the Innovation Diffusion theory, which includes six stages: initiation, adoption, adaptation, acceptance, routinization and infusion. The initiation stage, corresponding to the unfreezing phase of the Change Model, indicates that, when organizations face problems or opportunities, they began to search for useful solutions. The adoption and adaptation stages, corresponding to the change phase of the Change Model, indicate that organizational members are willing to implement the technology and adapt to its impacts. The acceptance, routinization and infusion stages correspond to the frozen phase of the Change Model and refer to the period when users accept the use of the technology; their acceptance can be recognized through an evaluation of performance and satisfaction. Through these stages, the wide use of the technology becomes part of the organizations routines (Cooper & Zmud, 1990).

Despite the technological adaptation model of Kwon and Zmud (1987) constituting six stages, most studies focus on the prior stages of initiation, adoption, adaptation and acceptance. Fewer studies focus on the routinization and infusion stages, when users combine technology use with organizational routines and gain most benefits from the integration. Organizational routines, however, have been studied broadly by scholars of organizational behavior. Thus, related organizational routines theory will be helpful in an exploration of the routinization stage of the technological adaptation process.

According to a dictionary definition, routines are “detailed regulations and compliance activities of the regular course, such as standard operating procedures.” Organizational routines have the following four characteristics: (1) repetition; (2) recognizable pattern of action; (3) multiple participants; (4) interdependent actions (Cohen, 1991).

Organizational routines can save costs and improve efficiency for our daily activities. However, organizational routines are also the main cause of rigidity when environments change. They might make mistakes or lost opportunities for innovation. Organizations could be inefficiency without integration by organizational routines. In the other hand, people usually get suboptimal solutions and reduce performance when excessively rely on organizational routines. Therefore, organizational routines could be considered as a double-edged sword (Cohen & Bacdayan, 1994), rapidly developing new routines

or adopting appropriate routines are the sources of competitive advantage and also the characteristics of successful organizations (Cohen, 1991). Nelson and Winter (1982) proposed that organizational routines are similar with skills, therefore organizations can be regarded as social networks embedded with organizational routines.

In addition, organizational routines are presented in the forms of documentation of standard operating procedures, shared practices or norms within community members. They might be coded with explicit texts, or shared in implicit ways. Organizational routines usually only cover general principles and rules of activities, and they do not cover the special cases with different situations. As a result, in different situations, the actual behaviors of participants might be different according to their interpretation. Organizational routines inevitably retain the characteristics of improvisation. Thus, organizational routines are repetitively executed in organizations, but their contents are not necessarily constant (Feldman & Pentland, 2003).

Organizational routines are the results of organizational learning (Argote, 1999). The Changes of organizational routines, regardless of emerging routines or amendments of prior routines, are the accumulation of organizational learning process (Levitt & March, 1988; Nelson & Winter, 1982). In other words, current organizational routines are built by past learning, error correction, and continuous improvement. Managers have to appropriately execute the daily activities with repetitive procedures (routines) and creative tasks (innovations) for the tradeoffs between efficiency and flexibility (Feldman & Pentland, 2003).

The tasks of auditors consist of a series of repetitive procedures, among which include: audit planning, risk assessment, auditing procedure design, data collection and analysis, working papers and auditing report writing, and follow-up tracking. These auditing activities are organizational routines with specific patterns and interactions among people from different departments. To enhance the efficiency and quality of auditing, there are many principles and standards guiding the procedures of auditing activities, but the characteristics of improvisation, risk assessment and professional judgments are very important for the execution of auditing, which makes the tasks of auditors more complex than other organizational routines.

From the view of organizational routines theory, although CAATTs help organizations get the benefits of automation, accuracy, and quick analysis, some auditors might question that automated auditing is based on explicit audit procedures, whereas many unexpected situations with variant rules happen in the processes of auditing, thus making it unfeasible to define the complete auditing procedures which cover various scenarios in advance. So, one of the critical factors is to provide the flexibility to auditors (improvisational behavior) together with the explicit and precise procedures of automatic

computer programs (predefined organizational routines).

From the literature discussed in this section, we can find that the adaptation process from CAATs adoption to the implementation of a continuous auditing system is affected by the auditing environment, skills of auditors, decisions by chief auditing executives, and the interaction between auditors and IS staff. The scope of the research target is not limited to CAATs itself but also includes business processes, control activities, auditing procedures and enterprise information systems. The phenomenon of CAATs adoption and use could be considered as technological adaptation processes, which involve adoption improvisation activities to change prior organizational routines into new organizational routines.

### 3. Study design

In order to understand the adaptation process of enterprises using CAATs, our research design adopts an exploratory study via a single case. The selected case company is referred to as ‘Alpha Company’ in this study. The period of analysis from 2006 to 2009 covers the time when Alpha Company decided to adopt CAATs and their continuous use of CAATs. Alpha Company developed the automatic auditing procedures for the four transaction cycles, and continues to fulfill the enhancement. Therefore, the technological adaptation process of Alpha Company could help us understand how companies adapt through the adoption and adaptation stages and the acceptance and routinization stages.

This study starts from July 2008 and ends in May 2009. The sources of data come from interviews (see Table 1), internal documents and public information. The researchers interviewed the Chief Audit Executive (CAE) and Chief Information Officer (CIO) and the members of CAATs projects. To increase the accuracy of the interviewee’s responses, and go back to the initial situation of use, the researchers first asked the interviewees the course of events for adoption and implementation of CAATs, and followed up with the

**Table 1** The Interview Activities and Interviewee List

Interviewee	Job Title	Frequency	Interview Time
CAE	Auditor-General	2	December 2008/March 2009
Internal Audit Staff	Senior Auditor	2	October 2008/March 2009
Internal Audit Staff	Financial Auditor	1	March 2009
CIO	Associate Manager	2	December 2008/March 2009
IT Staff	Director	1	March 2009
IT Staff	Database Administrator	2	December 2008/March 2009
Project Consultants	Project Manager	2	July 2008/May 2009



adaptation and routinization processes. The researchers used open questions and focused on emerging concepts and themes in the technological adaptation process.

In addition to the transcripts of interviews, the researchers also analyzed internal documents and public information, as the following shows, to understand the usage of CAATTs in Alpha Company:

- (1) Company information: company profiles, organizational charts, annual financial reports, etc.
- (2) Documentation of CAATTs projects: flowcharts, project task item lists, audit item lists, audit programs, data dictionary, minutes of meetings, etc.
- (3) Documentation of auditing: documentation of the internal control system, audit plans, working papers and audit reports, etc.

## **4. Case description and analysis**

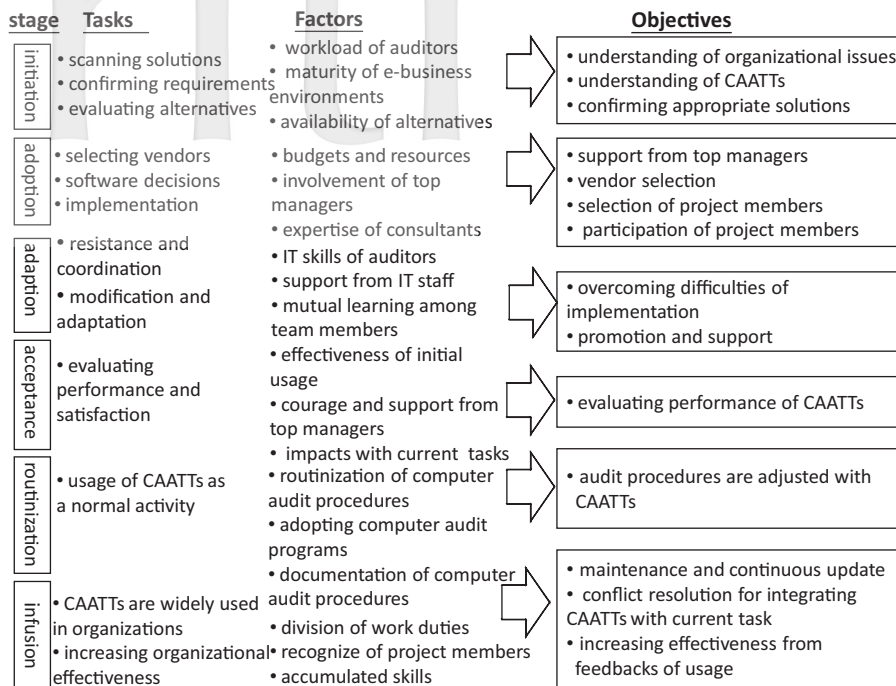
### ***4.1 The initial and continued use of CAATTs***

We divide the technological adaptation process of Alpha Company into two periods for easy comparisons: one is the initial period of use, which includes the initiation, adoption and adaptation stages, and the other is the continued period of use, which includes the acceptance, routinization, and fusion stages. In the initial use phase, Alpha Company first tried to adopt CAATTs on their sales and receivables cycle, and in the continued use phase, Alpha Company continuously implemented three projects, which includes production, procurement and payroll cycles. Each phase is described as the sequences of pre-implementation, implementation and ex-implementation phases. The objectives, tasks and factors of each stage are summarized in Figure 1.

#### ***4.1.1 The initial use period: pre-implementation phase***

Alpha Company has a highly integrated information system; the management values the monitor and control of information processing activities. The IT staffs maintain the enterprise information system by themselves. The CAE of Alpha Company thought manual auditing is constrained by manpower and budget. For the purpose of increasing the effectiveness of the internal control system and decreasing the expenditure of auditing, the CAE started to implement the CAATTs project in 2006.

The auditors of Alpha Company have been trained in the use of CAATTs software; however, they still did not know how to use CAATTs in practice. So the CAE hired an external consulting team to assist the project and decrease the workload of the auditors during the implementation phase. The consultant thought it was not easy to discuss the computer



**Figure 1** Objectives, Influencing Factors, and Tasks in Each Stages of the Technology Adaptation Process

auditing procedures only with CAATs software, so he designed a series of documents as the analysis and design tools.

At the beginning of the initial period of use, the consultant arranged a kick-off meeting with the CAO and the CIO to obtain the consensus of both. Although the CIO did not recognize the need for computer auditing, and also questioned the performance of the CAATs software, after the explanations of the consultant and with the strong support of CAE, the CIO was willing to assist the project. The meeting was concluded with the following agreements: the audit items would be prepared by the auditors, whereas the IT staff would help auditors to understand the current system processes and provide the required data files, and the consulting team would be responsible for the design, testing and documentation of computer auditing programs.

#### 4.1.2 The initial period of use: implementation phase

Initially, because of the lack of experience of the project members, the progress of project implementation was slow. The project meetings were chaired by auditors, IT staff, and the consulting team. In these meetings, project members discussed together setting project plans, auditing scope, auditing items, risk assessment for each auditing item, and the feasibility of analysis using computer auditing procedures.

During these meetings, consultants found that the auditors were used to the pervious field detection and were not familiar with the process flow of the enterprise information systems and the embedded application controls. Therefore, some auditing items were not applicable for computer auditing; some controls had been embedded in the information systems, but the auditors were not informed. So they required the assistance of IT staff to confirm the feasibility of the computer auditing procedures.

On the other hand, the consulting team is based on these feasible auditing items and recognized required data files from IT staff, and also confirmed the definition of the fields in these data files. However, it was difficult to communicate between IT staff and auditors, because IT staffs were not familiar with the auditing rules, and auditors were not familiar with the relationships of fields among multiple tables. The consultant played the important role of collaboration to explain the auditing objectives and technical illustrations to both. In addition, impacted by the heavy workload of IT staff, data confidentiality and authorization issues, and time-consumption associated with downloading and converting data from the mainframe, the schedule of the project resulted in serious delays.

After obtaining electronic data files, the consulting team used CAATTs software to execute the control test, data was filtered by auditing rules, and the abnormal transactions were extracted. The transaction data was sent to the auditors to confirm the reasonableness and reasons. If necessary, the auditors would modify the auditing rules and re-check several times for the extracted results. When the steps of analysis were confirmed as reasonable, the consulting team would write down the automatic procedures as computer programs. Meanwhile, the auditors would track the reasons of unusual records based on the analyzed results, and prepare the working paper for the auditing report. The consulting team wrote the analysis documentation according to the auditing procedures and the auditing objectives.

#### *4.1.3 The initial period of use: post-implementation*

The first CAATTs project needed 9 months to be completed because of the unfamiliarity with CAATTs by project members and the huge discrepancy in knowledge background among them; however, CAE and the auditors were satisfied with the achievements. The CAE confirmed that the automatic auditing programs can decrease the time and resource required for repeated auditing procedures and increase the efficiency of auditors with more coverage of data analysis. He also praised the consultants for the systematic analysis and documentation methods, and promoted this methodology as a guideline for following projects. He expected the auditors could apply the methodology and develop other automatic auditing procedures by themselves.

#### *4.1.4 The period of continued use: pre-implementation phase*

After the successful completion of the CAATTs project, the CAE wanted the scope of automatic auditing to be extended to multiple transactions cycles. He hoped the auditors could familiarize themselves with the development of computer auditing programs and be proficient with CAATTs software. Therefore, in addition to engaging the consulting teams to continue developing the other cycles, such as procurement, production and payroll cycles, the CAE requested the project members to take CAATTs training, and take active roles in the subsequent projects.

#### *4.1.5 The period of continued use period: implementation phase*

Since the auditors experienced the effects of CAATTs in their project, they knew what kinds of auditing items were applicable for computer auditing. So it was more efficient for the auditors to make a list of computer auditing items and to proceed with risk assessments. After an internal department meeting, they engaged the consultants with the IT staff for feasibility analysis in the first project meeting.

As the auditors were unable to grasp the updated status of business application controls, they still needed the assistance of IT staff to identify the appropriateness and feasibility of each computer auditing item. This step helped to remove these issues that were under control. So, the awareness of IT staff of internal control systems and acceptance with the values of CAATTs projects is very important for the implementation of projects. For example: IT staff with a supportive attitude not only explained the information flows and processing rules, but also enthusiastically pointed out the weak areas of current application controls. However, another IT staff serving as database administrator might focus on the efficiency of database servers and the security issues of information, but would not be concerned with whether the data elements are applicable for the auditing items.

Alpha Company then built a new database server, whose data is synchronized with the mainframe; consequently making it is easier to retrieve data directly from the new database server. The auditors could use the CAATTs software to download the authorized data by themselves. This increased the efficiency and independence of auditors. However, the auditors still required the assistance of IT staff to confirm the meaning of data fields and location of data files, such as the status codes for each transaction forms, and classification codes used for analysis. This information was essential for computer auditing procedures.

The consulting team was still responsible for the tasks of data importing, validation, and analysis. Although different transaction cycles were assigned to different staff, most of the staffs were part-time students, who just learned how to operate CAATTs software

without auditing experiences. However, by referring to the documentation on previous projects and examples of similar computer auditing programs, they could get started quickly, and completed the required programs on schedule.

The involvement of the auditors and familiarity with CAATs software still played an important role in the CAATs projects. Based on the rotation system in Alpha Company, most auditors come from various business units. Some of them are determined not to be auditors in the long term, and some of them might only assist field auditing by collecting information; hence, they would not be active in CAATs training. That is to say, some auditors keep a wait and see attitude for these projects.

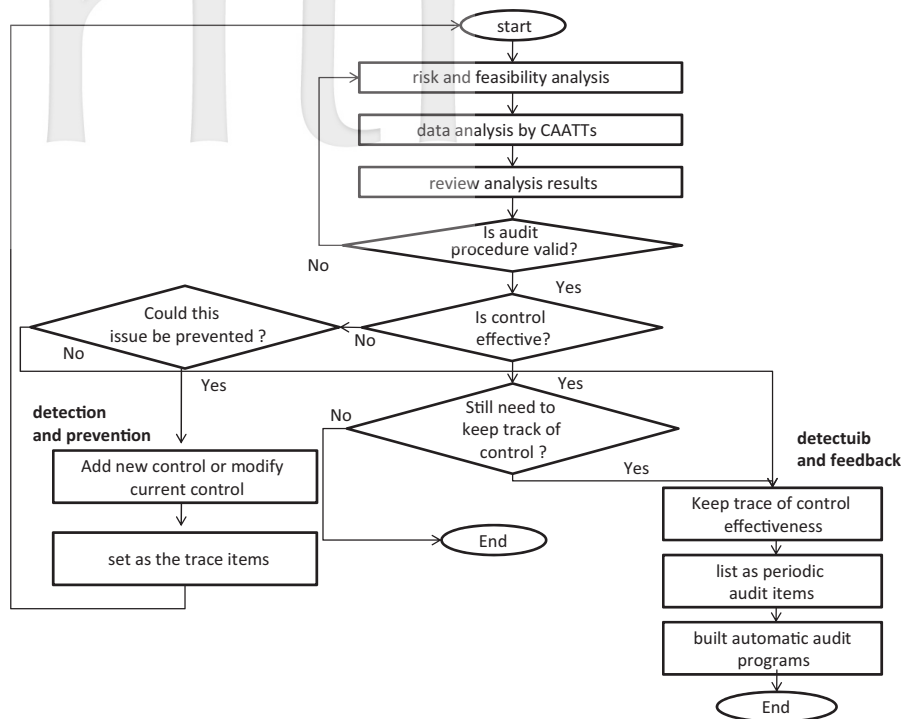
#### *4.1.6 The period of continued use: post-implementation phase*

After the initial use of the CAATs project on sales cycle and a following up with three projects on different transaction cycles, the auditing items developed in these projects covered the major areas of regular auditing activities in Alpha Company. The auditors began to use these automated auditing programs, which were developed by the consulting team, as pre-audit activities to help find out the abnormal transaction, and then conducted follow-up auditing.

The CAE was satisfied with the outcome of these CAATs projects, but still recognized the necessity of self-reliance for auditors in implementing CAATs projects. From the interviews, we find that the key for CAATs implementation is not the insufficiency of computer skills for auditors, but the fact that they worry that the increase of automated auditing programs will become a heavy workload in terms of maintenance. The auditors hope the IT staff to undertake the maintenance and development of automated programs. On the other side, the CIO wanted the auditors to have the ability to use CAATs tools and maintain autonomy, while the IT staffs focus on the enterprise information systems. The IT staff is only responsible for data file access authorization and database server maintenance. The consultant also believed that auditors should not only rely on reports generated by automated programs, although they still require the ability to use CAATs for analysis conducted by themselves. Thus, either error messages would be caused by changed data environments or new auditing items could be upgraded and maintained by the auditors, fundamentally enhancing their independence and effectiveness as auditors.

#### *4.2 Case analysis*

In Figure 2, we present the process flow of Alpha Company, which integrates the computer auditing process with the field auditing activities, computer control test, and tracking items. Alpha Company implemented the CAATs by projects at first, and gradually changed as continuous auditing became embedded in the routine auditing



**Figure 2** The Integration of Manual Auditing Procedures and Computer Auditing Procedures

activities of different transaction cycles. The implementation of each project helped the auditors to view the current status of application controls, whether manual or computer based controls. The initial analysis of each project helped to modify the detective rules of abnormal data and improve the effectiveness of current controls. After the cause-effect analysis of abnormal data, the auditors discussed with IT staff or staff of related departments to add or modify current control procedures and list them as tracking items. If the risk of some operations could not be decreased by preventative control procedures, and the risk was over the tolerance, then the related computer auditing procedures were added in the continuous auditing system, which would be executed by timely automated programs to monitor the current status of critical operations.

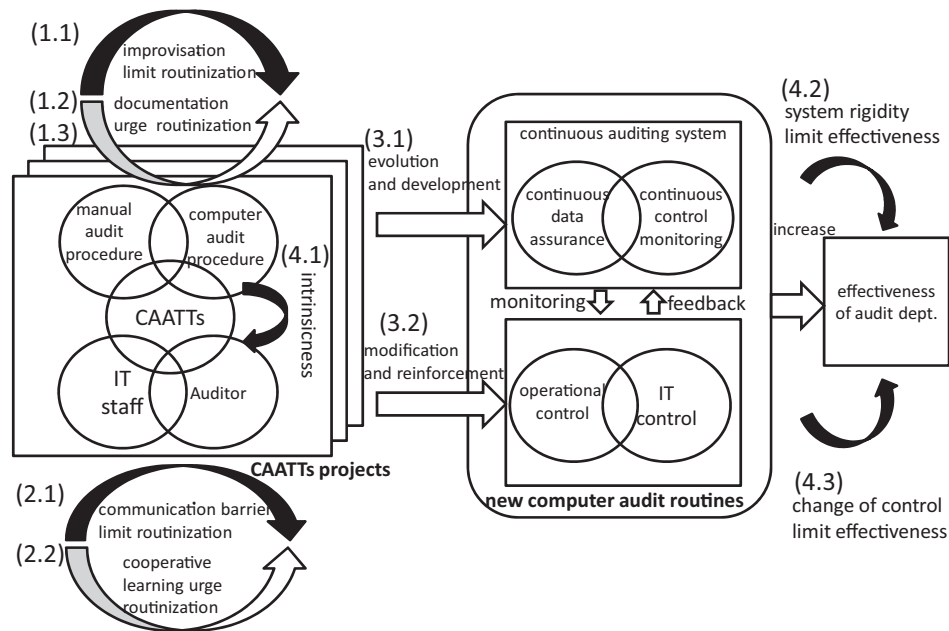
Compared to traditionally manual form auditing, we found that Alpha Company changed its auditing activities from information gathering and preliminary risk assessment to control tests (these could be considered as the evolution of routines). The auditors were more familiar with IT application controls through cooperative learning with IT staff. Thus, whereas the auditors used to ask their clients modify their errors in the past (old routine), now the auditors designed new application controls to prevent the mistakes (emergence of new routine). In addition, the cost of time and effort of routine activities

were reduced by the use of the continuous auditing system, thus the auditors could focus on other auditing tasks with high risks (evolution of routines).

While the auditors were not familiar with CAATTs at first, now they recognized the efficiency and effectiveness of CAATTs. The IT staff was initially resistant to convert and download data for the auditors, but they also found a more efficient way to provide data. In other words, Alpha Company developed an effective methodology to reduce the time and costs of CAATTs implementation. They also used the features of the continuous auditing system, such as real-time control and monitoring, to increase the benefits of CAATTs implementation. The new auditing methodology from CAATTs adoption to the use of a continuous auditing system is the result of the technological adaptation process through organizational learning.

### 4.3 Research findings and discussions

As mentioned in the section of literature review, whether or not computer auditing techniques can be utilized in organizations, the key issue is how to support and enhance current routines, and then convert them into new organizational routines. Figure 3 presents the development of computer auditing routines and related factors among the adaption process. The research findings and discussions are based on the drivers and resistance of routine adaptation, following with the emerging routines and related constraints.



**Figure 3** The Research Framework and Findings

#### 4.3.1 *The drivers and resistance of computer auditing routines*

**[Finding 1.1] The characteristics of improvisation in auditing activities will reduce the wiliness to use CAATs. The balance and complementary between human risk assessment and automated auditing are the key for the development of computer auditing routines.**

In the case company, most of the auditors maintain the attitude of wait and see for CAATs adoption. The CAE thought maybe the auditors were not familiar with the software. However, even with training and compulsory use, some auditors were still negative about CAATs. After interviews, we found that the senior auditors value the knowledge and experiences garnered from field auditing. These help auditors identify problems and confirm the auditing scope. In other words, senior auditors emphasize the improvisational characteristics of risk assessment in auditing activities. Risk assessment is the response for the information from target areas with personal judgments or suggestions from other members. Decisions making activities for risk assessment are executed in timely pressure and limited information.

In auditing activities, risk assessment and determining the causes of abnormal data need impromptu decision-making with situational characteristics. The characteristics of structural analysis with predefined procedures for automated programs make it not easy to solve undefined situations (Searcy, Woodroof & Behn, 2003). Thus, the improvisational characteristics of auditing activities will reduce the wiliness to use CAATs. Alles et al. (2009) also considered how to utilize the efficiency and accuracy of automated auditing programs, while maintaining the flexibility of result interpretation for auditors, retrieving data according to different situations, analyzing with real-time judgments are the bottlenecks for the use of a continuous auditing system.

On the other side, to lower the improvisational characteristics of auditing activities was also the motivation of the CAE to adopt CAATs. From the opinions of the CAE, the manual auditing methods are more dependent on the experiences of auditors, are not easy to learn for new comers, and sometimes the tasks are done in a muddled manner because of the of half-heartedness. However, from the thorough examination of computer auditing programs, there is the realization that the auditing scope is more comprehensive and reliable. Computer auditing programs help reduce the uncertainty of human decision-making and help the collaboration among auditors with efficiency and objectivity. In summary, the balance and complementary between human risk assessment and automated auditing are the key for the development of computer auditing routines.

**[Finding 1.2] The characteristics of explicitness from computer auditing documentation will enhance the efficiency of the CAATs project, and the emergence of computer auditing routines.**



**[Finding 1.3] The knowledge engineering features of computer auditing activities will help transform personal implicit knowledge into explicit knowledge shared by groups.**

In the four CAATs projects of the case company, we find that: The documentation of CAATs project built in the first project is very helpful for the implementation of subsequent projects. Even though members involved in the follow-up projects are new entrants who lack experiences, after they refer to the previous documentation as guidelines, they can quickly and effectively apply the same method on other different projects.

As most auditing activities have clear procedures, analysis procedures and reporting principles, using CAATs documentation to support auditing activities is similar to using manual auditing programs. The documentation helps integrate computer audit procedures with manual processes and also helps auditors understand the procedures of automated programs.

In addition to guiding the implementation of projects, the documentation, such as meeting minutes and analysis documents, also help project members clarify the implicit rules of fuzzy decisions into accurate procedures, which could be executed by computer programs. These analysis processes could be considered as the formalization process of knowledge engineering activities (Foguem et al., 2008).

Dowling and Leech (2007) also proposed the similar opinion: The key elements for auditing automation are how to clarify the vague knowledge hidden in manual auditing procedures and specify the knowledge as explicit rules. In other words, the analysis and design of automated auditing procedures, will transform the personal implicit knowledge, such as the operations and controls of each departments, the processing flow of enterprise information systems, etc., into explicit knowledge shared by groups after the project meetings. The explicit knowledge is easy to learn or imitate by new entrants (the emergence of new routines).

**[Finding 2.1] The communication barriers caused by the differences in expertise limit the emergence of computer auditing routines.**

**[Finding 2.2] Cooperative learning among project members helps the emergence of computer auditing routines.**

From the case company we find that: Because computer auditing activities are different from the traditional manual form of auditing, activities such as retrieval of electronic data, information system control tests, and examination of abnormal data require the assistance of IT staff. They cannot be done alone by auditors. However; the

communication barriers caused by different expertise prohibit the implementation of CAATs projects. For example, IT staffs tend to use the same platform and programming language with enterprise information systems, so auditors find it difficult to accept the software. Also, auditors are unfamiliar with tools with which automated programs and continuous auditing systems are developed and how maintenance should be conducted. Most IT staffs also do not understand the risk assessment and control testing procedures for auditing activities; thus, sometimes they will project a negative attitude toward CAATs projects. In addition, the analysis needs the help of IT staff to confirm the causes of abnormal data. However, when the auditors recognize the areas of control weakness, they usually will be considered as the lack of control in information systems. The auditing results will add the workload of IT staff in terms of modifying the information system. Therefore, the IT staffs, who are the facilitators for CAATs projects, embarrassedly become as the negligence holders. This reduces the willingness for IT staffs to participate in the CAATs projects.

Though the knowledge gap among different experts causes barriers in communication, it also becomes the starting point for cooperative learning among project members. Through discussions and problem solving, individual skills and professional knowledge emerge and are infused into the organizational routines (Julian, 2008). For example, through the assistance of IT personnel, the auditors were able to quickly understand the logic of application controls, which is the key for effective risk assessment; the IT staff, for their part, used the opportunities to re-check the correctness and effectiveness of application controls by participation in the project. These helped to amend or reinforce the control mechanisms of operations.

In Alpha Company, we also found that the common training courses of CAATs, which teaches auditors how to operate the software, are insufficient for auditors. However, after the implementation of several projects and continuous use, the project members accumulated the computer auditing techniques for various scenarios. In addition, with the assistance of consulting teams, project members with different professional backgrounds learned how to develop computer auditing procedures fitting the business contexts of Alpha Company.

This phenomenon supports the argument of Becker et al. (2005), which clarifies the difference between organizational routines and personal skills by stating that collective nature is the distinctive feature for organizational routines. The projects, involving many departments, will help these functional communities, which work in different vertical divisions, gradually form a new community of computer auditing. Thus, the cooperative learning among project members help the emergence of computer auditing routines.

#### 4.3.2 *The emergence of computer auditing routines*

**[Finding 3.1] The computer auditing programs developed in the CAATTs project are helpful for auditors transforming CAATTs applications into continuous auditing systems, and evolving them into emerging routines.**

**[Finding 3.2] The results of computer auditing with cause-effect analysis of abnormal data, contribute to updating and reinforcing control activities and operations.**

From the case analysis, we found that the scripts of CAATTs software could be converted to the automated auditing system, which can be executed regularly. So the auditors could use the automated auditing system to assist regular auditing tasks, and these programs could be executed more frequently than manual auditing. Thus the auditors could timely and with less cost find the abnormal data. This improved the efficiency of auditors and made the auditors more willing to use CAATTs.

In addition, as the scope covered by the automated programs continued to extend, the auditors gradually changed their auditing procedures. They used the reports of the automated auditing system as the basics of risk assessment and activities arrangements. The use of the automated auditing system shortened the auditing periods, increasing auditing frequency. In Alpha Company they use the workflow system to provide real-time exception reports by definition. So the CAE and department managers can use the system to monitor the status of operations. The automated auditing system has become the continuous auditing system of Alpha Company.

Although Hammer (1990) proposed that the implementation of information systems should redesign or reengineer current processes to avoid a focus only on the automation of current operations, which would limit great potential benefits, the rules of auditing activities are implicit and improvisational, so to redesign the overall auditing activities in advance is not easy. The hybrid approach of integrating manual and computer auditing is easier for promoting automated auditing in daily auditing activities (Alles et al., 2009).

From the above, the computer auditing programs developed in the CAATTs project are helpful for auditors transforming CAATTs applications into continuous auditing systems and evolving them as emerging routines. The results of computer auditing, with cause-effect analysis of abnormal data, contribute to updating and reinforcing control activities and operations.

#### 4.3.3 *The restrictions of computer auditing routines*

**[Finding 4.1] The implicit features of the automated auditing system restrict auditors in reviewing and understanding the meaning of auditing programs. These increase the rigidity of computer auditing programs.**

**[Finding 4.2] The rigidity of automated auditing systems limits the maintenance and expandability of the systems.**

Despite what has been reported, we still cannot be too optimistic on the use of automated auditing systems. The limitation of CAATs software and continuous auditing systems also emerged in the case company. For example: in the case company, CAATs software could support the analysis of auditing activities, but manipulation by data fields did not easily indicate the logical relationships among data fields. In other words, for the auditors, who are not familiar with computer programs and data structures of databases, it is difficult to quickly grasp the semantic meaning of computer programs (Li, Huang & Lin, 2007). The implicit features of CAATs manipulation and computer programs also hide the risk factors and the rule of auditing procedures. This will increase the difficulty of maintenance and expandability for computer auditing procedures and become the barriers for the integration with manual auditing procedures. Therefore, the rigidity of computer auditing programs restricts the improvisation of auditing activities.

In addition, as the auditing scenarios changed, the automated programs continued to be modified with more complexity and were more difficult to maintain. So the auditors argued with the IT staff as to who should be responsible for maintenance of the automated auditing system? Although automated auditing systems can be executed repetitively and rapidly, and improve the efficiency of regular auditing, the design and maintenance of automated auditing systems is more complicated than manual auditing procedures. This causes the resistance of auditors, who intend to avoid burden of system maintenance. As the auditor of the case company stated, “Our expertise is to focus on risk assessment and control test. We are not professional IT staff, so the burden of maintenance will decrease our performance.”

As the statements indicated in Finding 1.1, how to keep the flexibility of auditing activities with the automated auditing system is the key in terms of conducting computer auditing. In particular, the risk of companies will alter with changes in environments and organizations. The lack of semantic meanings in computer auditing programs hide the factors of risk assessment and the rules of the auditing procedures, therefore, it also has significant impacts on the benefits of continuous use for automated auditing systems.

**[Finding 4.3] The change of operations and information systems will affect the long-term benefits of automated auditing systems.**

In the case company, the rules of application control were not recorded in detail in the documentation of internal control. In addition with the implicit features of computer programs, the operation risks will alter when operations or information systems changes. This will produce the weakness of control or even result in the lost of functions of automated audit systems.

Current automated auditing systems operate on the basis of data field manipulation and computer programs embedded within the structure of the database. Process redesign, organizational restructuring and the replacement or updating of information systems will cause the errors or dysfunction of systems and increase the burden of maintenance. For example, when the sales departments of the case company become separate business units, the location and data files of sales transactions change after the adjustments. This would lead to full revision of the overall computer auditing programs.

Alles et al. (2006, 2009) also proposed the similar opinions. Systems using general auditing software are based on the data oriented approach (named as CDA: Continuous Data Assurance), which makes it not easy to monitor the real-time status of controls. How to develop continuous monitoring systems with continuing changes in information systems and control activities remains a major bottleneck for continuous auditing systems.

## 5. Conclusion

### 5.1 Contributions of this study

Previous studies on CAATs usage mostly focused on personal skills, attitudes and the support of top managers. Fewer studies explore the drivers and resistance of CAATs implementation on a group level. In this study, we analyzed the technological adaptation process for CAATs in a case company, which implemented four CAATs within three years. We took the theoretical viewpoints of organizational routines to explore how the auditors integrated computer auditing procedures with manual auditing activities, and transform the CAATs manipulation into the continuous auditing system. The technological adaptation process extends previous routines and leads to the emergence of new organizational routines.

From the case study and a discussion thereof, we conclude: Cooperative learning among project members and the documentation of projects contributes to the emergence of computer auditing routines; the continuous auditing system based on computer auditing programs also contribute to the emergence of routines. However, the improvisational characteristics of auditing activities, the implicit features of computer auditing programs, and the rigidity of continuous auditing systems causes the auditors to resist using CAATs tools, and restricts the emergence of computer auditing routines and the flexibility of auditing activities.

The main contributions of this study are as follows:

For the companies planning to adopt CAATs or who have tried to use CAATs, this study will help organizations comprehend the difficulties which they may face and how to

overcome them. In addition, this study provides a solution on how to implement CAATTs projects, and transform them into continuous auditing systems. The study also revealed the interactions among continuous auditing systems, control mechanisms, information systems, auditing procedures and work adjustments of related personnel. These research results are in accordance with the suggestions provided by Brown, Wong and Baldwin (2007): Case studies are necessary for the areas of continuous auditing. They help understand the key issues for building continuous auditing systems, and also the critical factors underpinning CAATTs implementation.

Concerning the arguments of previous studies relating to the ease of use of CAATTs and the importance of IT skills for auditors, we find that this contradiction is caused by the specialization of both tasks and knowledge. Although the general auditing software is easy to use for auditors, without the assistance of IT staffs, the auditors cannot successfully complete the analysis of electronic data extracted from enterprise information systems. In addition, the lack of semantic meaning in the software manipulation and computer auditing programs mainly restrict the accurate review and maintenance of automated auditing systems.

### *5.2 Suggestions for practitioners*

The practical suggestions for companies planning or who have tried to use CAATTs are as follows:

- (1) The documentation of computer auditing procedures will help CAATTs to be integrated with manual auditing procedures, and ease the burden of maintenance of computer programs.
- (2) It is insufficient to build the computer auditing routines only by documentation, because it is not easy to change the auditing methodology of auditors. It still depends on the cooperative learning environment of project members.
- (3) The implementation of CAATTs projects requires different areas of expertise. The duties and tasks of each project member should be clear and consistent with their expertise. This will enhance the willingness of participants and encourage collaboration and mutual learning with each other.
- (4) The implicit features of computer auditing program increase the rigidity of computer auditing procedures and the continuous auditing system. It is suggested that auditors use the documents with clearly defined format and legend. This will help staffs to effectively review the correctness and reasonableness of computer auditing procedures.

- (5) After the improved understanding of application control by auditors, and enhanced comprehension of auditing procedures for IT staff, the CAATTs project will be implemented more smoothly and will also be helpful in terms of the emergence of computer auditing routines. The conflict among project members will decrease and there will be less misunderstanding among them.

## Acknowledgements

Thanks for the helpful suggestions of reviewers and the assistance of Yi-Shan Lin, and thank the National Science Council grant funding for this research, grant project No. NSC-98-2410-H-224-005. In addition, this paper is a revised and expanded version of a paper entitled 'From CAATTs Adoption to Continuous Audit Systems Implementation: The Analysis Based on Organizational Routines Theories,' presented at International Conference on Accounting and Information Technology (ICAIT 2010) which was hold at Chung Cheng University, Chiayi, Taiwan, in 7 July, 2010.

## References

- Alles, M.G., Kogan, A. and Vasarhelyi, M.A. (2002) 'Feasibility and economics of continuous assurance', *Auditing: A Journal of Practice and Theory*, Vol. 21, No. 1, pp. 125-138.
- Alles, M.G., Kogan, A. and Vasarhelyi, M.A. (2008) 'Audit automation for implementing continuous auditing: principles and problems', paper presented at the Ninth International Research Symposium on Accounting Information Systems, Paris, France, December 13.
- Alles, M.G., Kogan, A. and Vasarhelyi, M.A. (2009) 'Principles and problems of audit automation as a precursor to continuous auditing', Working paper, Department of Accounting, Business Ethics & Information Systems, Rutgers Business School, Newark, NJ, September.
- Alles, M.G., Tostes, F., Vasarhelyi, M.A. and Riccio, E.L. (2006) 'Continuous auditing: the USA experience and considerations for its implementation in Brazil', *Journal of Information Systems and Technology Management*, Vol. 3, No. 2, pp. 211-224.
- Argote, L. (1999) *Organizational Learning: Creating, Retaining and Transferring Knowledge*, Springer, New York, NY.
- Becker, M.C., Lazaric, N., Nelson, R.R. and Winter, S.G. (2005) 'Applying organizational routines in understanding organizational change', *Industrial and Corporate Change*, Vol. 14, No. 5, pp. 775-791.

- Bhimani, A. (1996) 'Securing the commercial internet', *Communications of the ACM*, Vol. 39, No. 6, pp. 29-35.
- Braun, R.L. and Davis, H.E. (2003) 'Computer-assisted audit tools and techniques: analysis and perspectives', *Managerial Auditing Journal*, Vol. 18, No. 9, pp. 725-731.
- Brown, C.E., Wong, J.A. and Baldwin, A.A. (2007) 'A review and analysis of the existing research streams in continuous auditing', *Journal of Emerging Technologies in Accounting*, Vol. 4, No. 1, pp. 1-28.
- Burnett, S. (2003) 'The future of accounting education: a regional perspective', *Journal of Education for Business*, Vol. 78, No. 3, pp. 129-134.
- Chang, S.-I., Wu, C.-C. and Chang, I.-C. (2008) 'The development of a computer auditing system sufficient for Sarbanes-Oxley section 404 -- a study on the purchasing and expenditure cycle of the ERP system', *Information Systems Management*, Vol. 25, No. 3, pp. 211-229.
- Cohen, M.D. (1991) 'Individual learning and organizational routine: emerging connections', *Organization Science*, Vol. 2, No. 1, pp. 135-139.
- Cohen, M.D. and Bacdayan, P. (1994) 'Organizational routines are stored as procedural memory: evidence from a laboratory study', *Organization Science*, Vol. 5, No. 4, pp. 554-568.
- Cooper, R.B. and Zmud, R.W. (1990) 'Information technology implementation research: a technological diffusion approach', *Management Science*, Vol. 36, No. 2, pp. 123-139.
- Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1989) 'User acceptance of computer technology: a comparison of two theoretical models', *Management Science*, Vol. 35, No. 8, pp. 982-1003.
- Debreceeny, R., Lee, S.-L., Neo, W. and Toh, J.S. (2005) 'Employing generalized audit software in the financial services sector: challenges and opportunities', *Managerial Auditing Journal*, Vol. 20, No. 6, pp. 605-618.
- Dowling, C. and Leech, S. (2007) 'Audit support systems and decision aids: current practice and opportunities for future research', *International Journal of Accounting Information Systems*, Vol. 8, No. 2, pp. 92-116.
- Dutton, J.M. and Thomas, A. (1984) 'Treating progress functions as a managerial opportunity', *Academy of Management Review*, Vol. 9, No. 2, pp. 235-247.
- Elliott, R.K. (2002) 'Twenty-First century assurance', *Auditing: A Journal of Practice and Theory*, Vol. 21, No. 1, pp. 139-146.



- Elliott, R.K. and Jacobson, P.D. (1997) 'Adding value to audits', *CA Magazine*, Vol. 130, No. 9, pp. 35-37.
- Feldman, M.S. and Pentland, B.T. (2003) 'Reconceptualizing organizational routines as a source of flexibility and change', *Administrative Science Quarterly*, Vol. 48, No. 1, pp. 94-118.
- Foguem, B.K., Coudert, T., Béler, C. and Geneste, L. (2008) 'Knowledge formalization in experience feedback processes: an ontology-based approach', *Computers in Industry*, Vol. 59, No. 7, pp. 694-710.
- Gallegos, F. and Looho, A. (2000) 'IS audit training needs for the 21st century: a selected assessment', *Journal of Computer Information Systems*, Vol. 41, No. 2, pp. 9-15.
- Gehrke, N. and Wolf, P. (2010) 'Towards audit 2.0 -- a web 2.0 community platform for auditors', paper presented at the Forty-Third Hawaii International Conference on System Sciences, Koloa, HI, January 5-8.
- Hammer, M. (1990) 'Reengineering work: don't automate, obliterate', *Harvard Business Review*, July-August, pp. 104-112.
- Huang, S.-M., Hung, Y.-C. and Tsao, H.-H. (2008) 'Examining the determinants of computer-assisted audit techniques acceptance from internal auditors' viewpoints', *International Journal of Services and Standards*, Vol. 4, No. 4, pp. 377-392.
- Janvrin, D., Lowe, D.J. and Bierstaker, J. (2008) 'Auditor acceptance of computer-assisted audit techniques', Working paper, College of Business, Iowa State University, Ames, IA, December.
- Johnson, B.M. and Rice, R.E. (1987) *Managing Organizational Innovation: The Evolution from Word Processing to Office Information Systems*, Columbia University Press, New York, NY.
- Julian, J. (2008) 'How project management office leaders facilitate cross-project learning and continuous improvement', *Project Management Journal*, Vol. 39, No. 3, pp. 43-58.
- Kogan, A., Sudit, E.F. and Vasarhelyi, M.A. (1999) 'Continuous online auditing: a program of research', *Journal of Information Systems*, Vol. 13, No. 2, pp. 87-103.
- Kwon, T.H. and Zmud, R.W. (1987) 'Unifying the fragmented models of information systems implementation', in Boland, R.J. and Hirschheim, R.A. (Eds.), *Critical Issues in Information Systems Research*, John Wiley and Sons, New York, NY, pp. 227-251.
- Lanza, R.B. (2005) 'What are the common reasons to not use audit software?', *AuditSoftware.Net*, available at <http://www.auditsoftware.net/community/why/articles/commonNOT.htm> (accessed 3 March 2010).

- Levitt, B. and March, J.G. (1988) 'Organizational learning', *Annual Review of Sociology*, Vol. 14, No. 1, pp. 319-338.
- Lewin, K. (1952) 'Group decision and social change', in Swanson, G.E. (Ed.), *Readings in Social Psychology*, Holt, New York, NY, pp. 459-473.
- Li, S.-H., Huang, S.-M. and Lin, Y.C. (2007) 'Developing a continuous auditing assistance system based on information process models', *Journal of Computer Information Systems*, Vol. 48, No. 1, pp. 2-13.
- Lindow, P.E. and Race, J.D. (2002) 'Beyond traditional audit techniques', *Journal of Accountancy*, Vol. 194, No. 1, pp. 28-33.
- Lord, A.T. (2004) 'ISACA model curricula 2004', *International Journal of Accounting Information Systems*, Vol. 5, No. 2, pp. 251-265.
- Mahzan, N. and Lymer, A. (2010) 'Adoption of computer assisted audit tools and techniques (CAATs) by internal auditors: current issues in the UK', *JPS Accounting Forums*, available at <http://www.jps-dir.com/Forum/uploads/1364/Mahzan.pdf> (accessed 3 March 2010).
- Nelson, R.R. and Winter, S.G. (1982) *An Evolutionary Theory of Economic Change*, Belknap Press of Harvard University Press, Cambridge, MA.
- Ramamoorti, S. and Weidenmier, M.L. (2004) 'The pervasive impact of information technology on internal auditing', in Bailey, A.D., Jr., Gramling, A.A. and Ramamoorti, S. (Eds.), *Research Opportunities in Internal Auditing*, The Institute of Internal Auditors Research Foundation, Altamonte Springs, FL, pp. 301-377.
- Rezaee, Z., Elam, R. and Sharbatoghlie, A. (2001) 'Continuous auditing: the audit of the future', *Managerial Auditing Journal*, Vol. 16, No. 3, pp. 150-158.
- Rice, R.E. and Rogers, E.M. (1980) 'Reinvention in the innovation process', *Science Communication*, Vol. 1, No. 4, pp. 499-514.
- Searcy, D., Woodroof, J. and Behn, B. (2003) 'Continuous audit: the motivations, benefits, problems, and challenges identified by partners of a big 4 accounting firm', *Proceedings of the Thirty-Sixth Hawaii International Conference on Systems Sciences (HICSS' 03)*, Big Island, HI, January 6-9, pp. 210-219.
- The Institute of Internal Auditors (2009) '2009 IT audit benchmarking study: executive summary and report', *GAIN Annual Benchmarking Study*, available at <http://www.theiia.org/guidance/benchmarking/gain/knowledge-services/2009-it-audit-benchmarking-study/> (accessed 3 March 2010).

Tyre, M.J. and Orlikowski, W.J. (1994) 'Windows of opportunity: temporal patterns of technological adaptation in organizations', *Organization Science*, Vol. 5, No. 1, pp. 98-118.

Van de Ven, A.H. (1986) 'Central problems in the management of innovation', *Management Science*, Vol. 32, No. 5, pp. 590-607.

Vasarhelyi, M.A. (2002) 'Concepts in continuous assurance', in Arnold, V. and Sutton, S.G. (Eds.), *Researching Accounting as an Information Systems Discipline*, American Accounting Association, Sarasota, FL, pp. 257-271.

Zhao, N., Yen, D.C. and Chang, I.C. (2004) 'Auditing in the e-commerce era', *Information Management and Computer Security*, Vol. 12, No. 5, pp. 389-400.

### About the author

**Chia-Ming Sun** is an Assistant Professor in the Department of Accounting at the National Yunlin University of Science and Technology in Taiwan. He received his Ph.D. in information management from National Chiao Tung University. His research interests include information technology auditing, information technology governance, and enterprise information systems. He has industrial experiences and worked as consultant, information system manager and information system auditor in manufacturing companies.