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A Comparison of the Information Technology Knowledge of United States and German Auditors

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Abstract. The International Federation of Accountants has stated that competence in information technology is imperative for the professional accountant due to its pervasive use in the business world. Auditors would normally be expected to have higher knowledge than the average accountant since they must audit the work of many different clients with diverse information systems. We surveyed 2,500 United States and German auditing professionals to determine their self-reported knowledge levels (IT self-efficacy) of 36 information technologies, some of which include various emerging technologies. Responses totaled 587 for a 23.5% overall response rate. A factor analysis of the 36 individual technologies revealed five underlying general constructs. Response statistics indicated both countries lacked significant knowledge for three of these five constructs.

Scores were then culturally standardized to appropriately compare United States and German responses. German auditors had significantly higher knowledge for the construct of networking and data transfer. U.S. auditors had significantly higher knowledge for three constructs: ecommerce technologies, general office automation, and audit automation technologies. No differences were found for the construct of accounting firm office automation technologies. This study provides a foundation and methodology by which future researchers can measure whether, as an "emerging technology" matures, greater convergence will occur over time across cultures in factor analysis, as in the case of the more mature construct, general office automations.

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1. INTRODUCTION

The International Federation of Accountants Education Committee has stated, “Information technology [IT] is pervasive in business, requiring the professional accountant to be competent in this technology” (IFAC 2006b, p. 5). Further, technology will continue to have a “dramatic impact on virtually every phase of the audit process” Bierstaker, et al (2001). Chang and Hwang (2003) comment on whether professional accountants are properly trained in IT, “given the dynamic nature of IT and its widespread adoption in business organizations, many in the accounting profession have voiced concerns over whether college education and professional training effectively and efficiently prepare accountants to meet these challenges.” The accounting profession performs many roles where IT is used. Certainly in light of large scale business failures such as Enron, MCI-WorldCom, Parmalat, Comroad, etc., one of the most critical roles is auditing. Janvrin, *et al*. (2008) examine the use of audit IT and the perceived importance of IT use.

IT knowledge requirements for independent auditors are higher than for the average accountant since they typically serve a wide variety of clients with diverse information systems. The International Education Standard 8 (IFAC, 2006a) states that the knowledge content within the education and development program for audit professionals should include IT. The knowledge content of the IT subject area should include the following:

- IT systems for financial accounting and reporting, including relevant current issues and developments, and
- Frameworks for evaluating controls and assessing risks in accounting and reporting systems as appropriate for the audit of historical financial information.

Lymer and Debreceny (2003) discuss issues that have developed as auditors have moved towards trying to provide assurance on corporate reporting via the Internet. They find gaps between technology utilization and professional responses, leading to the conclusion that, “…the actual pronouncements made thus far by the various bodies around the world fall considerably short as a response to the challenges that arise from current and future Internet reporting technologies.” This suggests that the international audit profession is having a problem adjusting to the rapidly changing technology landscape. “From computer-generated audit programs to audit software capable of testing the entire population of the client’s data, technology is essential for accountants to understand the client’s business processes and contend with the paperless audit environment” (Bierstaker, *et al*, 2001). The profession can benefit by identifying key technologies and conducting self-assessment to learn how knowledgeable its members are about these technologies. Toward that end, we identify 36 key technologies and survey the self-perceived IT knowledge level (IT self-efficacy) of U.S. and German auditors.

2. THEORY AND HYPOTHESES FORMULATION

According the technology acceptance model (TAM), a user’s perception of their computer knowledge (self-efficacy) increases their perceptions of ease of use of the technology and system usefulness, which in turn, can affect their behavioral intentions (Davis 1989). Thus, examining auditor’s perceptions of their IT skill levels should provide some insight into which technologies may be more likely to be viewed as useful and easy to use. Because of experience, users should have a greater comfort level with and knowledge of (self-efficacy) older, more mature technologies than with newer, emerging technologies.

We examine IT self-efficacy in two judgmentally selected countries. The U.S. was selected because of the size of its economy and highly developed audit profession. Germany was selected for a comparison because it is a continental European country with a large economy and highly developed audit profession. As the world’s third strongest national economy, Germany holds a leading position in terms of its total economic output. Germany has the highest gross domestic product and the largest number of inhabitants in the European Union. In global trading of goods and services, Germany is in second place after the U.S. Further, Germany is a good comparison country for the U.S. since it has been touted as a leader in IT security surrounding data protection and for moving the center of gravity away from Silicon Valley to places like Walldorf, Germany where SAP began (The Economist, 2003). Financial statements audited by German auditors are relevant for U.S. investors because of the listing of major German companies at the NYSE, but also due to subsidiaries of U.S. companies in Germany. Moreover, German companies are often customers or suppliers of U.S. companies.

As businesses increasingly become global, the necessity of cross-border audit teams is also increasing. Thus, an assessment of the skill levels of people in similar job positions, such as the auditors in this case, is important for global quality control. Germany, because of its comparability in terms of economics to the U.S., provides a good population of auditors for comparison to the U.S. Because of these similarities, we would expect that they would have relatively similar auditing skill levels.

Further, the primary function of external audits is to increase trust in financial statements. This function can only be fulfilled if an adequate audit quality is provided. Audit quality depends on an auditor's ability to detect errors (expertise) and auditor's willingness to report such errors (independence) (DeAngelo, 1981). In the current information age, IT knowledge is a very important element of auditor's expertise. If German auditors have less IT knowledge, then this may result in provision of lower audit quality, and ultimately lead to a lower level of trust by U.S. stakeholders in German financial statements (and vice versa, of course). Also, if auditors have lower IT self-efficacy, this may impact their perceived usefulness of emerging technologies, and lower the intention to adopt the technology. Thus, the main purpose of this paper is to reveal whether differences exist concerning the IT-related expertise (IT self-efficacy) between U.S. and German auditors. We propose the following hypotheses regarding the IT knowledge levels of auditors:

- H1: The perceived knowledge level (IT self-efficacy) of German and US auditing practitioners includes relevant, current information technologies.
- H2: German and US auditing practitioners have the same perceived knowledge (IT self-efficacy) of relevant, current information technologies.

This is an exploratory study, as we know of no other study that compares relative IT self-efficacy of auditors from different countries. As technology brings the world closer together, audit firms are faced with increasing their global reach. As such, understanding similarities and differences in the IT skill levels in various countries should be of interest to both the academic and practitioner communities. Since this study is exploratory, we do not have preconceptions regarding the relative skill levels. We have mentioned some of these reasons why we would expect similarities between the two groups, however, differences in the education systems do exist between auditors that study in the U.S. and those that study in Germany. The education system in Germany is more research-oriented than in the US and less emphasis is placed on preparation of the students for practice, and this may impact their relative skill levels.

First, however, an important question must be addressed - what are relevant, current information technologies? This paper reports the results of a literature search to identify significant audit technologies. It also reports on the results of 2,500 questionnaire surveys of auditor knowledge in the United States and Germany about the specific technologies uncovered in the literature search. The results should provide evidence whether to support the research hypotheses as well as provide individual auditors with a benchmark for examining their own knowledge levels.

Information Technologies

The IFAC defines information technology [IT] as:

> "…hardware and software products, information system operations and management processes, IT controls frameworks, and the human resources and skills required to develop, use and control these products and processes to generate the required information." (IFAC, 2006b, p. 5)

This is a rather broad based definition since it includes "human resources and skills" in addition to hardware and software products. The current study narrows this slightly by focusing on hardware and software products. "Because of the dynamic nature and broad spectrum of IT, assembling a complete list of IT topics that are important to accounting professionals is very difficult" (Chang and Hwang, 2003). We initially began with the 25 information technologies which were included in a survey of the Norwegian auditing profession (McKee, 2000) since we wanted our research to build on prior research. A subsequent literature search which included IFAC publications, AICPA publications, a variety of journal articles, and an electronic commerce book added 11 additional technologies for the U.S. and German surveys. These 36 technologies are listed and briefly defined in Table 1-Information Technology Definitions. The original sources from which we identified the technologies are also listed in Table 1.

ITEM	INFORMATION	Source

	TECHNOLOGY		
1	Word Processing	IFAC 11	computer program that facilitates entry and preparation of documents such as letters or reports.
2	Electronic Spreadsheets	IFAC 11	software which allows the auditor to enter either alphanumeric or numeric data and manipulate it either via standard functions or auditor programmed functions
3	E-Mail	IFAC 11	exchange of mail messages via Intranets and/or the Internet.
4	Electronic Working Papers	IFAC 11	software which generates a trial balance, lead schedules, and other schedules useful for the recording of evidence in an audit or assurance engagement
5	Internet Search & Retrieval	AICPA '94	permits user to search text that is in electronic format and retrieve, view, and print desired text.
6	Image Processing	Helms & Mancino '97	conversion of paper documents into electronic form through scanning and the subsequent storage and retrieval of the electronic image
7	Electronic Presentations	IFAC 11	software that facilitates the organization and use of text, voice, and/or images to communicate concepts
8	Generalized Audit Software	IFAC 11	computer program which helps the auditor access client computer data files, extract relevant data, and perform some audit function such as addition or comparison.
9	Expert Systems	IFAC 11	computer software that provides relevant information and/or decision models to assist a human in making a decision or accomplishing some task.
10	Embedded Audit Modules	AICPA '94	programmed routines incorporated into an application program which are designed to perform an audit function
11	Real-time Audit Modules		
12	Database Search & Retrieval	IFAC 11	software that uses relational structures between data files and facilitates varying data retrieval and use.
13	Simulation Software	Elliott '94	abstraction of some aspect of real system via software. Auditor may use model to evaluate the reliability of information from real world sources. This may be thought of as a very high level analytical review of a company's data.
14	Flowcharting/Data Modeling	AICPA '94	software using the source code version of programs to produce flowcharts of program logic
15	Computer Aided Systems Engineering Tools	IFAC 11	integrated package of computer tools that automate important aspects of the software development process to increase software development effectiveness in terms of productivity of systems development and quality of developed systems.
16	Encryption Software	Helms & Mancino '97	changing data using some type of encoding/decoding algorithm so that unauthorized persons who can access the encrypted data will not be able to read it or use it.
17	Groupware	Glover & Romney '97	software that permits auditors to categorize, store, and share data among themselves as well as communicate with each other about that data, preferably in a real-time mode.

18	Cooperative Client/Server Environment	Helms & Mancino '97	distribution of processing functions between two or more computers as in a local area network. This also includes end-user computing where users on the network also process and store data on their personal computers.
19	Workflow Technology	AICPA Top 10 '97	software and hardware that facilitates the capture of data in the work place to improve management of the business. For example, using an electronic scanner to record the movement of materials in a warehouse based on the barcodes on the materials.
20	Database Design & Installation	IFAC 11	software that permits the creation and use of relational structures between data files
21	Time Management & Billing Systems	IFAC 11	computer program which assists in capturing, managing, billing, and reporting time spent on professional activities.
22	Test Data	IFAC 11	a set of transactions processed by the auditor to test the programmed or procedural operations of a computer application
23	Small Business Accounting Software	IFAC 11	accounting software package used to record transactions, maintain general and subsidiary ledgers, and generate financial statements.
24	Digital Communications	AICPA Top 10 2000	bandwidth – telecommunications devices used to facilitate the rapid and unfettered transfer of data.
25	Tax Return Preparation Software	IFAC 11	software, perhaps incorporating expert knowledge, which assists the accountant/auditor in identifying relevant information, capturing and recording it in a manner that can be filed with tax authorities.
26	Firewall Software/Hardware	AICPA Top 10 2000	Part of "security technology" that enforces an access control policy between two networks.
27	User Authentication Systems	AICPA Top 10 2000	devices used to verify that a system user is who he/she claims to be.
28	EDI-Traditional	IFAC 11	transfer of data or payments electronically between computers using software that may, or may not, require human intervention to affect the transfer.
29	EDI-Web Based	Greenstein & Feinman, 2000	The extension to XML-based EDI
30	Wireless Communications	AICPA Top 10 2000	the ability to transfer digital data without the use of cables, twisted-pair, or fiber optics.
31	Agent Technologies	AICPA Top 10 2000	programmed modules that are given certain levels of authority and autonomy to act on behalf of their "supervisor", such as to decide whether to order more inventory and from which supplier
32	Intrusion Detection & Monitoring	AICPA Top 10 2000 & Greenstein & Feinman	Part of "security technology" that identifies unauthorized requests for services
33	Internal Network Configurations	IFAC 11	linkage of individuals and data through hardware and software systems that permit the exchange of various types of data.
34	External Network Configurations	AICPA Top 10 2000	– intranet, extranet, and Internet access devices than enable users physically separated from the server to access it.
35	Enterprise Resource Planning	McKee 2000	business-wide information systems that cross boundaries

36	Application Service Providers	McKee 2000	Companies which host (provide hardware, software and connectivity) for specific business applications

Table 1. Information Technology Definitions[1]

The technologies are not necessarily completely distinct from each other since many of them are based on similar information technology fundamentals or capabilities. For example, electronic spreadsheets may have data import/export capabilities and statistical analysis capabilities as do generalized audit software. Nevertheless, we believe that the technologies are distinct enough that audit professionals should be knowledgeable about each of them. Because of the rapidly changing and somewhat open ended nature of information technology, there could be other significant technologies which were not included in this survey.

Related Norwegian Prior Study

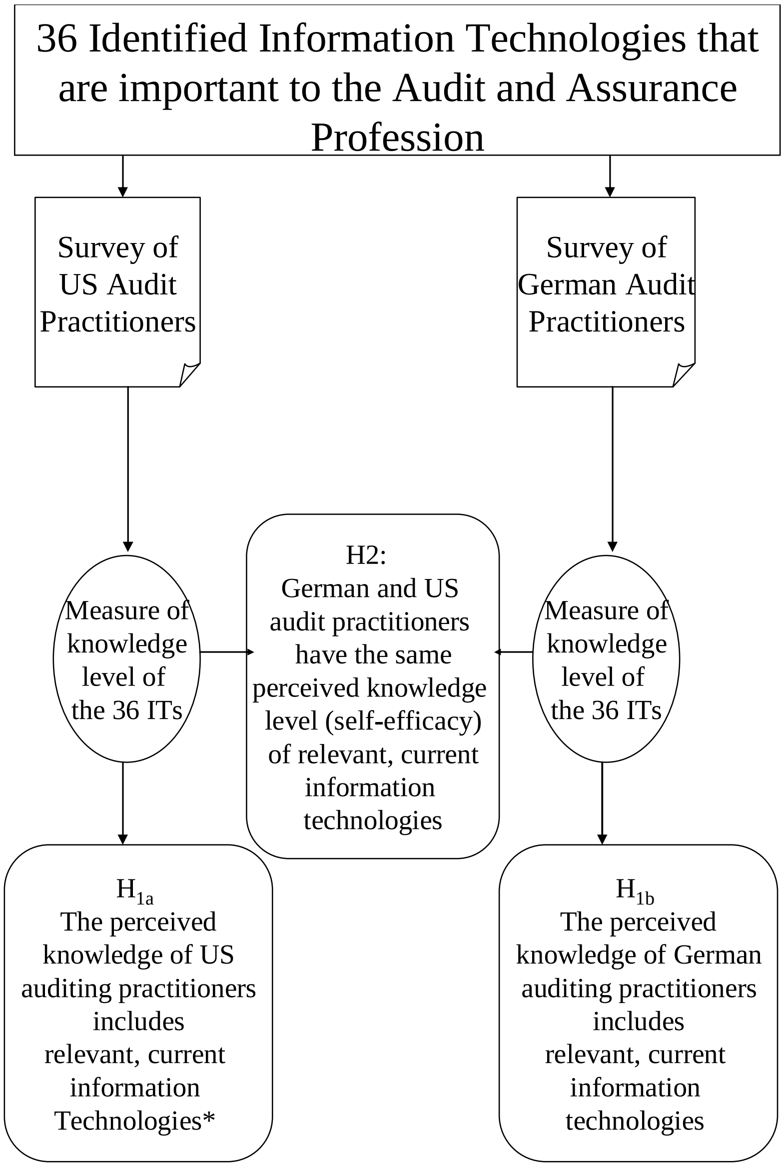
McKee (2000) conducted an information technology knowledge survey of the Norwegian practicing auditing profession during late 1998 and early 1999. The survey encompassed 25 information technologies. Major findings from this survey were:

- A large number of professionals indicated either no knowledge or relatively low levels of knowledge for the 25 information technologies surveyed.
- Female respondents rated their individual and overall knowledge lower than male respondents.
- 71% of the respondents believed they had received less than adequate coverage of information technologies in their college or university careers.
- 17.3% of the respondents self-rated their overall knowledge of information technology as either low or very low.
- "Big 5" audit firm respondents self-rated their overall knowledge of information technology higher than did other respondents [statistically significant at .05 level] in 20 of the 25 technologies surveyed.

[1] This table is taken from M. Greenstein and T.E. McKee, "Assurance Practitioners' and Educators' Self-Perceived IT Knowledge Level: An Empirical Assessment," International Journal of Accounting Information Systems, Vo. 5 (2004), 213-243.

3. METHODOLOGY

As previously noted, this study built on the McKee 2000 Norwegian information technology study. Eleven additional technologies were added to the Norwegian information technology survey instrument. This expanded survey containing 36 information technologies was then pre-tested and modified. The overall design of the research is illustrated in Figure 1.



*Previously examined by Greenstein & McKee [2004]

Figure 1.Research Designs

The survey instrument measures self-assessment of IT knowledge level. Self assessment of the technical knowledge of auditors is certainly not new (Kennedy and Peecher, 1997). In most cases, the research conducted in the psychology field indicates that individuals' likelihood assessments of their own knowledge are overconfident (Keren, 1991). These indications of overconfidence by auditors in self-assessments are generally supported (Solomon, *et al*, 1985; Moeckel and Plumlee, 1989; Moeckel, 1990; Kennedy and Peecher, 1997). Thus, the tradition of assessing self-assessed knowledge exists in the literature, but we will be conservative in our analysis of the results, realizing that respondents are likely to over-estimate their own knowledge base.

The expanded survey of 36 information technologies, in English, was then mailed to 1,000 accounting information systems and auditing professors and 1,000 audit practitioners in the United States during the first half of 2000 (Greenstein and McKee, 2004). Only the survey responses from the audit practitioners are included in this article. A German language survey, similar to the expanded survey used in the United States, was distributed in Germany during 2000-2001 to 1500 German professional auditors (McKee and Quick, 2003). This survey was not completely random as, after inspection of the randomly selected addresses, it was discovered that only one address was present for each office of the "Big 5" Audit firms. Thus, Big 5 auditors were underrepresented in the initial sample. As a result, one of the Big 5 audit firms was requested to distribute surveys internally. This resulted in 42% of the responses being from "Big 5" firms and 47% from "non-Big 5" firms with 11% not indicating a firm affiliation.

Surveys distributed to audit practitioners in the two countries totaled 2,500. There were 587 usable responses for a 23.5% overall response rate. Table 2-Survey Response Rates shows the various response rates for the two surveys. The survey results should be reasonably representative of the auditing professions in the two countries surveyed.

	United States	Germany	Total
Surveys Distributed	1,000	1,500	2,500
Completed Responses	246	341	587
Response Rate	24.6%	23.0%	23.5%

Table 2. Survey Response Rates

Demographic Response Data

Demographic data on the audit practitioners included in this survey is presented in *Table 3-Demographic Data On Respondents*. This data indicates that respondents represented a wide variety of ages, experience levels, and position levels.

	United States	**Germany**	**Overall**
Gender			
Male	59.4%	88.8%	70.7%
Female	39.0%	9.4%	27.7%
Missing	1.6%	1.8%	1.6%
Age In Years			
Minimum	23	24	23
Average	42	43.4	42.5
Maximum	72	71	72
Median	41	44	
Experience In Years			
Minimum	0	1	0
Average	12	17.6	14.2
Maximum	37	45	45
Median	15	17	
Current Position[2]			
Staff/Assistant	6%	4%	5%
Senior/Supervisor	16%	7%	13%
Manager	23%	25%	24%
Partner	50%	58%	53%
Other	4%	6%	5%
Missing	1%	0%	0%

Table 3. Demographic Data on Respondents

Female respondents comprised 39% of the U.S. responses as compared to only 9% in Germany. The German result is consistent with the fact that females currently comprise approximately 12.3% of Wirtschaftsprüfer and 13.8% of vereidigter Buchprüfer (the two categories of German auditors). We also note that the experience level of the German respondents averaged 18 years as compared to

[2] U.S. data is only for 103 respondents who indicated that they performed traditional audits.

only 12 years for the U.S. respondents, and the average position of German participants is higher. This suggests that, on average, the German respondents were more likely to be more highly experienced males than the U.S. respondents.

Response Variable Correlations

The questionnaire which respondents received asked them to rank their knowledge of the 36 information technologies on a 7 point scale anchored with terms as follows:

No Knowledge Expert Knowledge

1 2 3 4 5 6 7

Table 4-Information Technology Knowledge of Audit Practitioners shows the mean, standard deviation, and median of the actual U.S. and German auditor responses to the 36 information technology questions.

Item	**Information Technology**	**U.S. Unadj. Mean**	***Std. Dev.***	**Median**	**Germany Unadj. Mean**	***Std. Dev.***	**Median**
1	Word Processing	4.99	*1.18*	5	4.61	*1.19*	5
2	Electronic Spreadsheets	5.38	*1.20*	6	4.72	*1.30*	5
3	E-Mail	5.09	*1.17*	5	4.34	*1.30*	4
4	Electronic Working Papers	3.70	*1.73*	4	2.83	*1.66*	3
5	Internet Search & Retrieval	4.78	*1.32*	5	3.86	*1.41*	4
6	Image Processing	2.86	*1.60*	3	2.69	*1.41*	2
7	Electronic Presentations	3.38	*1.77*	3	3.30	*1.67*	3
8	Generalized Audit Software	2.94	*1.68*	3	2.76	*1.59*	2
9	Expert Systems	2.00	*1.35*	1	1.95	*1.35*	1
10	Embedded Audit Modules	2.08	*1.42*	1	1.95	*1.38*	1
11	Real-time Audit Modules	2.10	*1.42*	1	1.64	*1.09*	1
12	Database Search & Retrieval	3.51	*1.59*	3	3.05	*1.57*	3
13	Simulation Software	2.64	*1.54*	2	2.05	*1.35*	1
14	Flowcharting/Data Modeling	2.94	*1.60*	3	2.40	*1.48*	2
15	CASE Tools	1.66	*1.08*	1	1.51	*1.01*	1
16	Encryption Software	1.59	*1.06*	1	1.72	*1.16*	1
17	Groupware	2.80	*1.71*	3	2.50	*1.67*	2
18	Cooperative Client/Server Environment	2.73	*1.65*	2	1.98	*1.41*	1
19	Workflow Technology	1.96	*1.28*	1	1.50	*.97*	1

20	Database Design & Installation	2.48	*1.52*	2	1.95	*1.30*	1
21	Time Management & Billing Systems	3.67	*1.77*	4	3.22	*1.57*	3
22	Test Data	2.67	*1.69*	2	1.74	*1.26*	1
23	Small Business Accounting Software	4.52	*1.72*	5	4.58	*1.86*	5
24	Digital Communications	1.89	*1.28*	1	2.81	*1.65*	2
25	Tax Return Preparation Software	4.83	*1.84*	5	4.73	*1.99*	5
26	Firewall Software/Hardware	1.85	*1.25*	1	1.96	*1.32*	1
27	User Authentication Systems	1.77	*1.27*	1	2.02	*1.32*	2
28	EDI-Traditional	2.24	*1.47*	2	3.20	*1.68*	3
29	EDI-Web Based	2.20	*1.42*	2	2.74	*1.61*	2
30	Wireless Communications	2.78	*1.63*	3	3.08	*1.54*	3
31	Agent Technologies	1.81	*1.30*	1	1.64	*1.10*	1
32	Intrusion Detection & Monitoring	1.67	*1.19*	1	1.87	*1.20*	1
33	Internal Network Configurations	2.11	*1.44*	1	2.40	*.54*	2
34	External Network Configurations	1.78	*1.23*	1	1.86	*1.27*	1
35	Enterprise Resource Planning	1.85	*1.42*	1	1.59	*1.22*	1
36	Application Service Providers	1.98	*1.40*	*1*	1.40	*.89*	1

Table 4. Descriptive Statistics – Mean IT Knowledge Level – Raw Data
Respondents ranked their own knowledge of 36 information technologies on a 1 to 7 scale where 1 = No Knowledge and 7 = Expert Knowledge.

In order to determine if the overall IT knowledge results for the U.S. versus the German groups were related we computed the Pearson correlation coefficient for the mean values of the 36 information technologies in the two groups. This correlation coefficient was .911 which has a two-tailed significance of .000. This means that the overall IT knowledge results for the two groups are statistically significantly related.

Because cultural differences in response patterns to questionnaire scales may occur when an instrument is administered to subjects in different cultures, an adjustment was made to the data to culturally standardize scores (Leung and Bond, 1989 and Smith, Peterson & Schwartz, 2002).

$$SS(i,j) = [S(i) - \mu(j)] / \sigma(j)$$

where

- $SS(i,j)$ = subject's score for item i in culture j
- $\mu(j)$ = overall mean of all 36 item scores for culture j
- $\sigma(j)$ = overall std. dev. of item scores for culture j

- US: μ (j) = 2.7895 and σ (j) = 1.141
- Germany: μ (j) = 2.6114 and σ (j) = 1.0035

Such standardization techniques are not without bias, however. According to Fischer (2004) “dealing with cross-cultural response patterns is arguably one of the most challenging issues in cross-cultural survey research.” Smith (2004) illustrates that such adjustments might actually not reduce method biases, but instead communication styles and related cultural characteristics. Fischer (2004) points out that, according to these prior studies, that standardization could remove variation that is substantial and related to culture. Thus, in an effort to make sure that the analysis is robust to this cultural adjustment, we analyze and report any differences in results due to this transformation.

Because H1 does not compare the two populations (cultures) against one another, the raw data is used in that analysis. In examining H2, all analyses are conducted on both the raw data and culturally adjusted data, and any differences found are examined and discussed. Identifying such differences is important as evidence increasingly becomes available that “response bias might actually be a variable of substantive interest and a true indicator of cross-cultural differences” (Fischer 2004).

Factor Analysis of the 36 Technology Skills

As noted by Yu (2002) many IT technologies “…are interrelated and should not stand alone. For example, privacy, security, and mobile and wireless technologies are interrelated.” Accordingly, we believed a factor analysis of the 36 specific technologies might reveal more about possible interrelationships and fundamental technology constructs. The 36 items listed in Table 1 were factor analyzed on the perceived skill level response for the 36 information technologies to determine the number and character of the underlying constructs.

Because the two groups of auditors may be inherently different, factor analysis is conducted on each of the populations to determine if pooled analysis of the groups is appropriate. The results of the factor analysis extraction for the raw data and the culturally adjusted data discussed in this section were 100% identical when run on the raw data and the culturally adjusted data. Considering the standard transformation made to the data and the techniques of factor analysis, this is to be expected, and would certainly be suspect if the results were not identical. As illustrated in Tables 5 and 6, the items loaded slightly differently for the two groups. Factor analysis using Varimax rotation is used, and responses for each of the two groups loaded into six factors, explaining 67% and 66% of the variance respectively, for the US and German auditors. The individual factors and underlying items, as well as the relative explanatory value of the items, vary somewhat between the two populations.

The bolded, underlined items in Tables 5 and 6 identify the items that clearly loaded on only one component. The rule used in this process was to choose items with a score of .50 or better. The items in italics indicate those items that did not meet this criteria. For the U.S. auditors, three items did not prominently load onto any component: simulation software, flowcharting/data modeling, and cooperative client/server environment. For the German auditors, four items did not meet this criteria: database search and retrieval, flowcharting/data modeling, groupware, and database design and installation.

	Component / %Variance Explained					
	1 (23.4%)	2 (10.6%)	3 (10.6%)	4 (8.1%)	5 (7.7%)	6 (7.0%)
Word Processing	.099	**.814**	.057	.144	.042	.133
Electronic Spreadsheets	-.006	**.674**	.075	.291	.046	.190
E-Mail	.088	**.821**	.191	-.128	.135	-.002
Electronic Working Papers	.028	.318	**.557**	.173	.091	.203
Internet Search & Retrieval	.221	**.712**	.175	.086	.050	.145
Image Processing	.324	**.517**	.336	.100	.093	.020
Electronic Presentations	.211	**.563**	.235	.246	.294	-.219
Generalized Audit Software	.123	.207	**.645**	-.088	.078	.321
Expert Systems	.337	.118	**.603**	.310	.193	-.018
Embedded Audit Modules	.220	.184	**.802**	.172	.154	.070
Real-time Audit Modules	.277	.155	**.798**	.206	.183	.061
Database Search & Retrieval	.236	.438	.310	**.588**	.085	.075
Simulation Software	.334	.173	.426	.488	.120	.206
Flowcharting/Data Modeling	.335	.308	.302	.415	.268	.062
CASE Tools	**.558**	.053	.393	.094	.110	.176
Encryption Software	**.839**	.163	.182	.137	.073	.025
Groupware	.148	.195	.204	.171	**.602**	.037
Coop. Client/Server Environment	.427	.209	.061	.445	.359	.125

Workflow Technology	**.578**	.044	.177	.402	.392	.022
Database Design & Installation	.400	.210	.145	**.651**	.107	.155
Time Mgt. & Billing Systems	.188	.171	.188	.331	.283	**.638**
Test Data	.414	.071	.226	**.529**	.184	.242
Small Bus. Accounting Software	.108	.115	.122	.184	.052	**.832**
Digital Communications	**.749**	.163	.053	.204	.175	.153
Tax Return Preparation Software	.118	.066	.151	-.025	.018	**.856**
Firewall Software/Hardware	**.814**	.104	.191	.181	.124	.030
User Authentication Systems	**.832**	.096	.114	.226	.107	.063
EDI-Traditional	**.525**	.061	.169	.289	**.639**	.121
EDI-Web Based*	**.576**	.139	.160	.220	**.575**	.087
Wireless Communications	.455	.158	.155	-.134	**.633**	.287
Agent Technologies	**.651**	.047	.284	.129	.415	.104
Intrusion Detection & Monitoring	**.823**	.104	.267	.082	.110	.066
Internal Network Configurations	**.728**	.238	-.012	.117	.058	.224
External Network Configurations	**.862**	.138	.099	.085	.214	.100
Enterprise Resource Planning	**.601**	.138	.256	.201	.325	-.102
Application Service Providers	**.521**	.009	.237	.357	.356	.014

Table 5. U.S. Auditors- Rotated Component Matrix
Extraction Method: Principal Components. Rotation: Varimax with Kaiser Normalization.
Factor loadings are 100% identical using both raw data and culturally adjusted data.

	Component / % of Variance Explained					
	1 (18.4%)	2 (14.0%)	3 (12.2%)	4 (11.7%)	5 (6.8%)	6 (3.3%)
Word Processing	.187	.111	**.816**	.004	.276	.134
Electronic Spreadsheets	.170	.047	**.814**	.092	.260	.152
E-Mail	.123	.316	**.679**	.133	-.123	.096
Electronic Working Papers	.196	.241	.375	.349	-.165	**.606**
Internet Search & Retrieval	.120	.337	**.670**	.172	-.051	-.102
Image Processing	.227	.264	**.536**	.391	.013	-.298
Electronic Presentations	.191	.143	**.634**	.306	-.338	.024
Generalized Audit Software	.249	.169	.280	**.585**	.052	.398
Expert Systems	.248	.098	.015	**.730**	.195	.012
Embedded Audit Modules	.253	.183	.185	**.716**	.074	.102
Real-time Audit Modules	.401	.092	.122	**.698**	.062	.068

Database Search & Retrieval	.185	.381	.358	.464	.293	-.266
Simulation Software	.333	.255	.199	**.596**	.133	-.118
Flowcharting/Data Modeling	.447	.081	.402	.450	-.041	.051
CASE Tools	**.730**	.152	.181	.259	.049	-.032
Encryption Software	**.600**	.275	.253	.239	.037	.081
Groupware	.231	.336	.393	.380	-.328	.234
Coop. Client/Server Environment	**.508**	.488	.233	.302	-.051	-.105
Workflow Technology	**.681**	.175	.150	.405	-.059	-.044
Database Design & Installation	.488	.453	.306	.271	.009	-.327
Time Mgt. & Billing Systems	.138	**.548**	.096	.335	.226	.107
Test Data	**.611**	.373	.240	.183	-.009	-.076
Small Bus. Accounting Software	.135	.214	.014	.145	**.809**	-.070
Digital Communications	.219	**.575**	.232	.154	.276	-.115
Tax Return Preparation Software	.006	.234	.045	.164	**.838**	.013
Firewall Software/Hardware	**.634**	**.510**	.133	.059	.237	.054
User Authentication Systems	**.621**	.385	.093	.041	.317	.158
EDI-Traditional	.302	**.656**	.260	.116	.225	-.073
EDI-Web Based	.341	**.647**	.341	.124	.161	-.121
Wireless Communications	.097	**.645**	.166	.085	.174	.289
Agent Technologies	**.569**	.253	.090	.276	.255	.108
Intrusion Detection & Monitoring	**.688**	.423	.107	.190	.212	.137
Internal Network Configurations	.363	**.671**	.131	.167	.031	.065
External Network Configurations	.462	**.639**	.104	.109	-.088	.118
Enterprise Resource Planning	**.735**	.096	.154	.288	-.077	-.013
Application Service Providers	**.800**	.146	.087	.223	-.015	.061

Table 6. German Auditors- Rotated Component Matrix

Extraction Method: Principal Components. Rotation: Varimax with Kaiser Normalization.
Factor loadings are 100% identical using both raw data and culturally adjusted data.

In order to compare the US and German audit skill levels, having consistent and comparable constructs is desirable. Also, identifying structural differences in the two cultures is interesting and important to future researchers. Towards that end, Venn diagrams are used to visually identify logical, common constructs across the two groups as illustrated in Figure 2. The underlined items from the factor loading statistics in Tables 5 and 6 are grouped according their U.S. and German Components and overlaps can be readily seen. Two items for the U.S. group, EDI-Traditional and EDI-Web-based had loading scores of .50 or better on two components, accordingly these items are illustrated in Figure 2 under both components with an asterisk. One item for the German group, firewall, has loading scores of .50 or better on two items, and these items are illustrated in Figure 2 under both components with two asterisks.

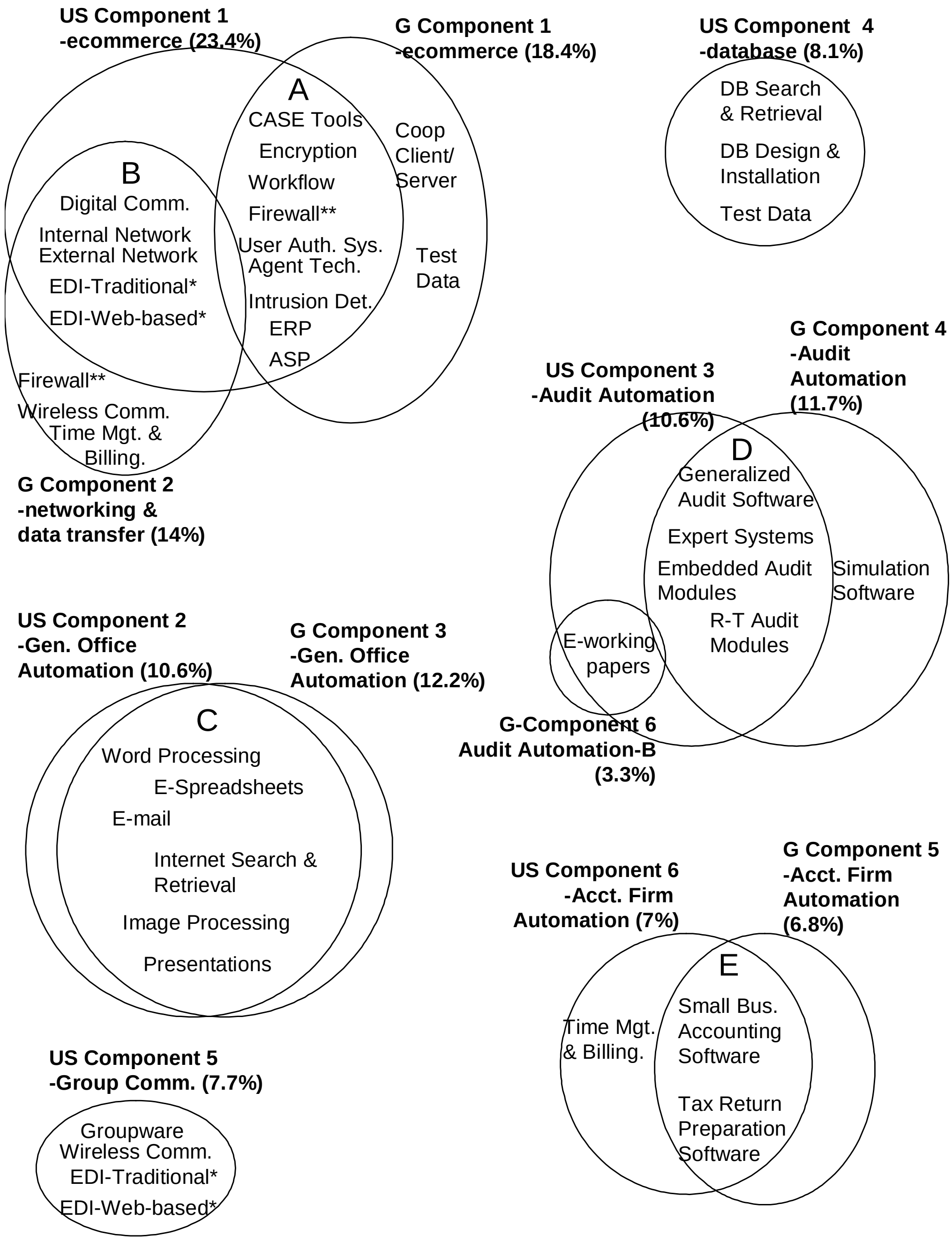


Figure 2. Component Comparison
* denotes items that load on two components for US auditors
** denotes item that loads on two components for G auditors

By identifying commonalities using Figure 2 as a visual aid, five "pooled" constructs are identified as A,B,C,D,E. Item A is labeled as E-commerce and Advanced Technologies. Item B is a new construct, not previously identified as a single construct by Greenstein and McKee[2004]. Essentially, for the US population the factor analysis groups many more items into the "e-commerce" construct, but the factor analysis of the German population groups these items into two distinct constructs. So, for purpose of comparing the two populations, we duly note that the US had more homogeneity in their responses on these e-commerce items than the German auditors. The more granular approach to comparing the two populations seems to provide more detailed comparison, therefore, Construct B breaks out these items into a separate construct labeled as Networking and Data Transfer. Construct C, General Office Automation, has 100% agreement between the two populations. Construct D, Audit Automation has very similar loading, with agreeance on four important audit technologies. Finally, construct E, Accounting Firm Automation includes two important technologies, but interestingly, time management and billing did not load onto this construct for the German auditors. Thus, interpretation of the factor analysis suggest the following pooled constructs:

1. E-commerce technologies
2. Networking and data transfer
3. General office automation technologies
4. Audit automation technologies, and
5. Accounting firm office automation technologies

Tests of H1 and H2

- H1: The perceived knowledge level (IT self-efficacy) of German and US auditing practitioners includes relevant, current information technologies.

To examine the first hypothesis, a benchmark is needed against which to measure the reported knowledge levels for the set of IT skills. Since we are independently assessing the perceived knowledge levels of the U.S. and German auditors, we use the raw data rather than the culturally adjusted data. We chose the midpoint of the response range as the benchmark. Figure 3 illustrates the distributions of the pooled items within each of the five constructs for the raw data. Those diagram skewed to the left indicate a tendency towards less knowledge (e-commerce, networking and data transfer, and audit automation) and those skewed to the right indicate a tendency towards greater knowledge (general office automation and accounting firm automation). Using a seven-point scale, the midpoint is 4, so we consider the percentage of respondents that are below the midpoint, meaning the percentage of respondents that selected 1, 2, or 3 on a 7-point scale with 1 being No Knowledge. If 50% or more of the respondents are below the mid-point, we conclude that the sample groups were not very knowledgeable for that technology.

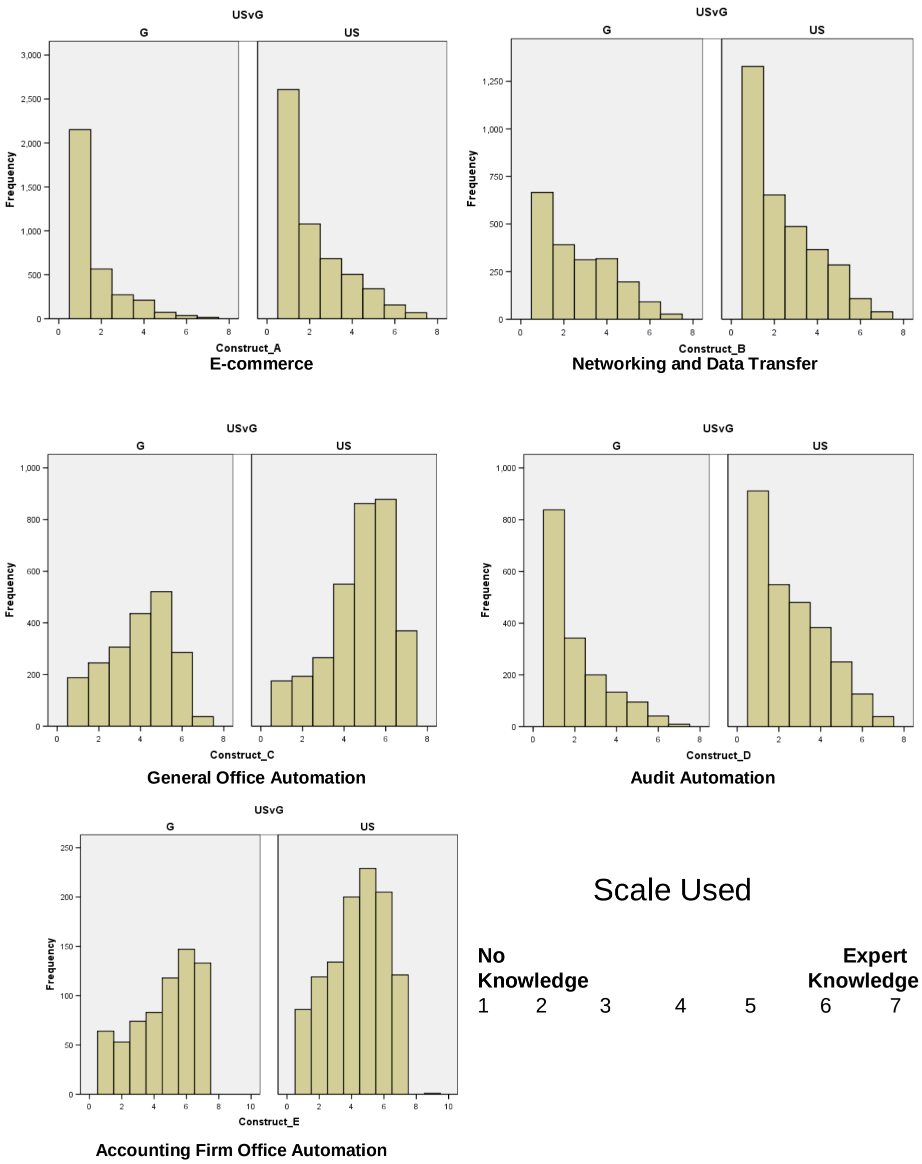


Figure 3. Histograms of Constructs – Raw Data

The results are also consistent with mean analysis. Chi-squared tests of distributions were conducted on each of the 36 items comparing a 50-50 distribution (1,2,3 vs. 5,6,7), and the results are noted in Table 7.

A **E-commerce/ Advanced Techn.**	**B** **Networking & Data Transfer**	**C** **General Office Automation**	**D** **Audit Automation**	**E** **Acct. Firm Office Automation**
Case Tools *94% < midp G ** *91% < midpt US **	**Digital Communications** *64% < midpt G ** *85% < midpt US **	**Word Processing** *61% > midpt G* ***** *72% > midpt US* *****	**Generalized Audit Software** *71% < midpt G ** *66% < midpt US **	**Small Business Accounting Software** *57% > midpt G ** *57% > midpt US **
Encryption Software *90% < midpt G ** *91% < midpt US **	**EDI-Traditional** *57% < midpt G ** *79% < midpt US **	**Electronic Spreadsheets** *64% > midpt G* ***** *82% > midpt US* *****	**Expert Systems** *86% < midpt G ** *84% < midpt US **	**Tax Preparation Software** *61% > midpt G ** *61% > midpt US **
Workflow Technology *94% < midpt G ** *87% < midpt US **	**EDI – Web-based** *69% < midpt G ** *80% < midpt US **	**E-mail** *50-50 G* *73% > midpt US* *****	**Embedded Audit Modules** *85% < midpt G ** *81% < midpt US **	
Firewall Software/Hardware *85% < midpt G ** *88% < midpt US **	**Internal Network Configurations** *76% < midpt G ** *80% < midpt US **	**Internet Search & Retrieval** *50-50 G* *61% > midpt US* *****	**Real-time Audit Modules** *92% < midpt G ** *81% < midpt US **	
User Authentication Systems *86% < midpt G ** *91% < midpt US **	**External Network Configurations** *87%< midpt G ** *87%< midpt US **	**Image Processing** *71% < midpt G ** *65% < midpt US **		
Agent Technologies *90% < midpt G ** *89 < midpt US **		**Electronic Presentations** *54% < midpt G ** *50-50 US*		
Intrusion Detection & Monitoring *88% < midpt G ** *90% < midpt US **				
ERP *90% < midpt G ** *86% < midpt US **				
Application Server Providers *94% < midpt G* *83% < midpt US*				
Reject H1 ***G:*** χ2=6616.9* ***US:*** χ2=5959.5*	***Reject H1*** ***G:*** χ2= 908.7* ***US:*** χ2= 2238.8*	***Accept H1*** ***G:*** χ2= 477.6* ***US:*** χ2= 1171.9*	***Reject H1*** ***G:*** χ2= 1491.2* ***US:*** χ2= 1197.9*	***Accept H1*** ***G:*** χ2= 83.1* ***US:*** χ2= 283.1*

Table 7 – Tests of H1
Pooled Constructs: Individual and Pooled c2 tests (*=significant at .05 or better)

Table 7 indicates a much higher proportion of respondents than 50% selecting 1, 2, or 3 for the following constructs: e-commerce technologies, networking and data transfer, and audit automation. Extremely high percentages of the respondents rated themselves lower than the mid-point for many of the individual technologies, such as 90-91% for encryption software, 86-90% for ERP, 86-91% for user authentication systems, and 88-90% for intrusion detection & monitoring! For the construct accounting firm office automation, both German and US auditors indicate a high degree of knowledge with these items as indicated by the high number of responses above the midpoint (scores of 5, 6, and 7). On the other hand, the evidence was not entirely clear for the general office automation construct. Both German and US auditors seem comfortable with word processing and electronic spreadsheets as evidenced by the high number of responses above the midpoint (scores of 5, 6, and 7). Both groups however, indicated a low knowledge level for image processing and average knowledge level for internet search and retrieval and electronic presentations. Pooled Chi-Squared tests for all of the items in each of the constructs are also conducted and the results are reported in Table 7 and summarized below:

Construct	H1
E-commerce technologies	Reject for both G & US
Networking and Data Transfer	Reject for both G & US
General Office Automation	Accept H1
Audit Automation	Reject for both G & US
Accounting Firm Office Automation	Accept H1

The overall interpretation is that both German and U.S. auditors only have adequate information technology for two of the five constructs. However, an alternative interpretation might be that knowledge of all the individual information technologies is not actually necessary to exercise professional judgment adequately. Many auditors may not perform tasks which require all the specific information technology knowledge surveyed. Also, they might rely on specialists to handle various information technology tasks.

- H2: German and US auditing practitioners have the same perceived knowledge of relevant, current information technologies (IT self-efficacy).

In the test of H2, the relative skill sets of the two groups are examined. Since the two groups are being compared against one another, the cultural adjustment is made. However, both the raw data and culturally adjusted data are analyzed and tested to see how robust the results are across the two data sets. Overall, the results were identical for 21 out of 36 (58%) technologies. For these 21 technologies, 18 were statistically significantly different between the two countries. For the remaining 15 items, the cultural adjustments affected the results significantly. In approximately one-half of the cases (8), the statistical significance increased from insignificant to significant because of the cultural adjustments. The remaining cases either decreased in significance (5 cases) because of the cultural adjustment or actually switched directions (2 cases). Thus, the cultural adjustment does indeed affect the significance at the individual item level.

Item	**Information Technology**	**Raw Data .05 or better**	**Culturally Adjusted Data .05 or better**	**Consistent**	**Type of Change**
1	Word Processing	US>G	No difference		-significance
2	Electronic Spreadsheets	US>G	No difference		-significance
3	E-Mail	US>G	US>G	Yes	
4	Electronic Working Papers	US>G	US>G	Yes	
5	Internet Search & Retrieval	US>G	US>G	Yes	
6	Image Processing	No difference	No difference	Yes	
7	Electronic Presentations	No difference	No difference	Yes	
8	Generalized Audit Software	No difference	No difference	Yes	
9	Expert Systems	No difference	US>G		+significance
10	Embedded Audit Modules	No difference	US>G		+significance
11	Real-time Audit Modules	US>G	US>G	Yes	
12	Database Search & Retrieval	US>G	No difference		-significance
13	Simulation Software	US>G	US>G	Yes	
14	Flowcharting/Data Modeling	US>G	US>G	Yes	
15	CASE Tools	US>G	US>G	Yes	
16	Encryption Software	No difference	US>G		+significance
17	Groupware	US>G	US>G	Yes	
18	Cooperative Client/Server Env.	US>G	US>G	Yes	

19	Workflow Technology	US>G	US>G	Yes	
20	Database Design & Installation	US>G	US>G	Yes	
21	Time Management & Billing Systems	US>G	No difference		-significance
22	Test Data	US>G	US>G	Yes	
23	Small Business Accounting Software	No difference	G>US		+significance
24	Digital Communications	G>US	G>US	Yes	
25	Tax Return Preparation Software	No difference	G>US		+significance
26	Firewall Software/Hardware	No difference	US>G		+significance
27	User Authentication Systems	G>US	US>G		Directional
28	EDI-Traditional	G>US	G>US	Yes	
29	EDI-Web Based	G>US	G>US	Yes	
30	Wireless Communications	G>US	G>US	Yes	
31	Agent Technologies	No difference	US>G		+significance
32	Intrusion Detection & Monitoring	G>US	US>G		directional
33	Internal Network Configurations	G>US	No difference		-significance
34	External Network Configurations	No difference	US>G		+significance
35	Enterprise Resource Planning	US>G	US>G	Yes	
36	Application Service Providers	US>G	US>G	Yes	

Table 8. Mann-Whitney U-test Results Comparison
Raw Data vs. Culturally Adjusted Data

In testing H2, we need to consider the significance and direction of any differences between the U.S. and German auditors for the pooled items under each construct. We also need to be cognizant of the impact on the results due to the cultural adjustment. Table 9 demonstrates the statistical significance of each of the individual items using Mann-Whitney test results for both the raw data and culturally adjusted data. Symbols are used to denote for each item the consistency between raw and adjusted data. Also, the items in each of the constructs are pooled and an F-test is used to determine the significant differences between the U.S. and German auditors. The construct level (pooled items) tests are run on both the raw data (RD) and the culturally adjusted data (CAD), and the results are completely consistent for four of the five constructs as reported in Table 9. The following results are found and also reported in Table 9:

Construct	H2
E-commerce technologies	Reject H2
Networking & Data Transfer	Reject H2

General Office Automation	Reject H2
Audit Automation	Reject H2
Accounting Firm Office Automation	Accept H2

A E-commerce	B Networking & Data Transfer	C General Office Automation	D Audit Automation	E Accounting Firm Office Automation
CASE Tools US>G ‡	**Digital Communications** G>US ‡	**Word Processing** G>US -	**Generalized Audit Software** No difference ‡	**Small Business Accounting Software** G>US +
Encryption Software US>G +	**EDI-Traditional** G>US ‡	**Electronic Spreadsheets** US>G -	**Expert Systems** US>G +	**Tax Preparation Software** G>US +
Workflow Technology US>G ‡	**EDI – Web-based** G>US ‡	**E-mail** US>G ‡	**Embedded Audit Modules** US>G +	
Firewall Software/Hardware US>G +	**Internal Network Configurations** G>US -	**Internet Search & Retrieval** US>G ‡	**Real-time Audit Modules** US>G ‡	
User Authentication Systems *Direction unclear*	**External Network Configurations** US>G +	**Image Processing** No difference ‡		
Agent Technologies US>G +		**Electronic Presentations** no difference ‡		
Intrusion Detection & Monitoring US>G *Direction unclear*				
ERP US>G ‡				
Application Server Providers US>G ‡				
Reject H2 **CAD: F= 12.8*** **RD: F= 12.9***	**Reject H2** **CAD: F=24.2*** **RD: F=20.6***	**Reject H2** **CAD: F=10.3*** **RD: F=20.5***	**Reject H2** **CAD: F=7.7*** **RD: F=8.1***	**Accept H2** **CAD: F=4.7*** **RD: F=1.1**

Table 9 – Tests of H2
Pooled Constructs: Raw Data (RD) and Culturally Adjusted Data(CAD) F-tests
‡ denotes consistent Mann-Whitney test results of RD and CAD, + denotes increased significance using CAD; - denotes decreased significance using CAD,
*two-tailed tests significant at.01 or better

The F-test results of pooled items for each of the constructs were statistically significant at .0001 or better for the both raw data and culturally adjusted data. The results indicate that for three of the constructs, e-commerce, networking and data transfer, and audit automation, U.S. practitioners have a statistically significant greater perceived knowledge level (IT self-efficacy) than the German practitioners. For one of the constructs, networking and data transfer, the German practitioners have a statistically significant greater perceived knowledge (IT self-efficacy) level than the U.S. practitioners. The F-test results were not robust across the raw data and culturally adjusted data for only one of the constructs, accounting firm office automation. For this construct, significant differences were found for the culturally adjusted data, but not the raw data. Because of these inconsistencies and the controversy surrounding the appropriateness of culturally adjusted data, we do not reject H2 for this construct.

Discussion of Results

When we consider the results of the testing of the two hypotheses, we get a more holistic view of similarities and differences in US and German auditors:

Factor 1 E-commerce Technologies	Factor 2 Networking & Data Transfer	Factor 3 General Office Automation	Factor 4 Audit Automation	Factor 5 Accounting Firm Office Automation
Reject H1	Reject H1	Accept H1	Reject H1	Accept H1
Reject H2 US auditors report greater knowledge level than G auditors	Reject H2 German auditors reporter greater knowledge level than US Auditors	Reject H2 US auditors report greater knowledge level than G auditors	Reject H2 US auditors report greater knowledge level than G auditors	Accept H2

On a seven-point scale with 7 being Expert Knowledge and 1 being No Knowledge, the overall means of the 36 non-culturally adjusted information technology knowledge (IT self-efficacy) for the US audit practitioner and German audit practitioners were very low at 2.79 and 2.61, respectively. The mean reported skill levels on three of the constructs are disturbingly low in both countries as indicated visually in Figure 3 and by the Chi-Square tests of distributions reported in Table 7. Specifically, we found that the skill sets of German and US audit practitioners were on the low side of a seven point scale, the mode was 1-No Knowledge, for three constructs: e-commerce technologies, networking and data transfer, and audit automation. We did find some good news, however, the skill sets for both groups are perceived as being on the high side for two constructs: general office automation and accounting firm office automation. These technologies are not really considered emerging technologies, so finding moderate to high knowledge levels on these two constructs is both comforting and provides logical validity to the overall results.

The other three constructs, however, are the more emerging technologies. Bierstaker, *et al* (2003) found that the percentage of internal auditors surveyed in 2002 that used various software was quite low, thus indicating that these technologies are still very much emerging, both in design and in use. For example, for e-commerce privacy and integrity, only 12% of the internal auditors used software, for specialized fraud, only 19% used software, and for continuous transaction monitoring, only 18% used software. For organizations with revenues less than $250M, no internal auditors surveyed used any of these types of software. The major reasons cited for not using such software was not cost, but that the software was not available. Cost was the second reason, however, thus indicating that if software is available, they either are not aware of it, do not fully understand the benefits from a cost-benefit perspective, or the newness of the software simply has too high of a price-tag that can only be afforded by larger organizations.

When the US and German auditor practitioners are examined in comparison with one another, both before and after making a cultural adjustment to the data, statistically significant differences are found between the two groups for four of the constructs: e-commerce, networking and data transfer, general office automation, and, audit automation.

For the construct e-commerce technologies, both German and US practitioners have very low perceived knowledge levels, and overall the US auditors tend to have higher skill levels. For the construct networking and data transfer, EDI (traditional and web-based), digital communications, and Internal Network Configurations, the German audit practitioners have higher perceived knowledge levels (IT self-efficacy) than their US counterparts. The historically greater wireless movement in Europe may explain their enhanced comfort level with wireless and network communications.

For the construct audit automation, both groups of practitioners have low perceived knowledge levels on all items. For three out of four items in this construct, the German audit practitioners had statistically significant lower self perceived knowledge than the US audit practitioners. One potential explanation for this finding could be that German auditors perform less tests of controls (and more test of details) than US auditors. Also, it may be due to a lower average size of client base in Germany. The only item for which no differences are found between the US and German auditors is generalized audit software.

Some good news from this study is that, overall, both US and German audit practitioners appear to be comfortable with general office automation. Both German and US practitioners have a medium to relatively high level of perceived knowledge on four of the six items in this construct: word processing, electronic spreadsheets, e-mail, and internet search and retrieval. While overall, the two groups are relatively comfortable with the technologies in this category, they are substantially less comfortable with image processing and electronic presentations than with the other four items in this construct. Overall, US auditors are slightly more comfortable with this construct than the German auditors, although not necessarily on all individual items.

For the construct accounting firm office automation, the results are not that different: both German and US audit practitioners have a relatively high level of perceived knowledge, which is more good news. This is not surprising because these types of technologies are those which many auditing practitioners are exposed to frequently. The US auditors, however, did report a statistically significant lower level of knowledge on this construct than did the German auditors using the culturally adjusted data, but not the raw data. Put another way, both US and German auditors are comfortable with accounting firm office automation, but the Germans may be more comfortable than their US counterparts. In Germany, relatively more sole practitioners and small audit firms exist, and bookkeeping and tax consulting services are much more important than audit services. Further, German tax laws are considered to be among the most complex in the world and even more complex than U.S. tax laws. This may account for the culturally adjusted results indicating that the German auditors are more knowledgeable that US auditors regarding tax return preparation software.

Research Limitations

All survey research has a number of limitations which may affect the usefulness and validity of the results. Some were acknowledged previously while others are discussed below. A general limitation of this type of research is that since the questionnaire asked the respondents to rank their own knowledge there is no way to determine if their rankings are an accurate depiction of actual knowledge. Kennedy and Peecher (1997) find that auditors are overconfident in their technical knowledge when performing self-assessments. Their study examined their self-perceived vs. actual knowledge of GAAP and GAAS, so their results may not be generalizable to the IT domain. However, if auditors are similarly overconfident in their assessment of their IT knowledge, then the need for increased professional development in this area is even greater.

Another limitation, as previously acknowledged, is that many of the technologies overlap conceptually. We were not able to find a technology taxonomy which would enable us to select conceptually distinct information technologies with which audit practitioners would be readily familiar. We attempted to overcome this limitation by conducting factor analysis and systematically identifying constructs and by examining aggregated items by construct.

Some IT knowledge may be more related to efficiency issues rather than effectiveness. Accordingly, lack of knowledge in some IT areas may not be as significant in terms of society relying on auditor work. One further limitation is that the 36 information technologies examined in this research were subjectively selected by the researchers from English literature. Equally significant technologies may not have been identified or selected. Additional technologies were not sought from the German literature.

We were only able to incorporate limited checking for non-respondent bias. This consisted principally of comparing sample means of early respondents to late respondents for significant differences, and no overall significant differences were found. The possibility exists that individuals who did not respond to this survey may have different information technology knowledge levels. Further, for the

German sample, the "Big 5" was basically represented by one "Big 5" firm and not all five firms. The results from this one firm may not be generalizeable to the other "Big 5" audit firms.

A final factor to consider is that the U.S. survey was English language based while the German survey was German language based. Although, careful translations were made and verified by other individuals, language differences could have affected the survey results. In some cases for the German survey English expressions were used since there was no apparent clear German equivalent.

4. CONCLUSIONS

As widely acknowledged in the literature, appropriate knowledge of information technology is critical for the auditing profession. This research measured IT knowledge for U.S. and German audit professionals via national surveys in each country. A principal finding is that a statistically significantly different knowledge level (IT self-efficacy) is found between the two countries for four of the five constructs identified in the factor analysis using both the raw data and culturally adjusted data: e-commerce technologies, networking and data transfer, general office automation, and audit automation. This raises the question of whether this difference was created by the educational system, firm training, or continuing professional education.

Another important finding was that more than 25% of the auditing profession in both countries self-rated their IT knowledge as "Less Than Adequate." This does not sound like the surveyed professionals believe they are meeting the "advanced level" of IT knowledge suggested by IFAC, and this suggests that the auditing professions in both countries need to address this issue if the profession is to appropriately meet the needs of society. Calibrating self-assessments of IT knowledge is important, and measuring auditors' knowledge levels of relevant IT knowledge is critical to the audit profession. Continuous improvement is unlikely if auditors are overconfident about their IT skill levels. Further, absent feedback about their true 'IT" skill levels, auditors will be unlikely to question, and certainly not improve their knowledge (Arkes et al. 1987). Further, the resources used to enhance auditors' IT skills "needs to be considered an 'investment' rather than a 'cost'" (Nance and Straub, 1996).

Another consideration in interpreting the results should be that knowledge of all 36 information technologies may not be necessary for many professionals to meet their responsibilities adequately. Many audit practitioners work in areas where some of the technologies may not be necessary or useful. Some of the information technologies may be necessary only for specific tasks. Selecting a "low tech" approach when IT is not useful can lead to improved performance, while "using technology that is not useful for the task may have minimal or even dysfunctional performance effects" (Nance and Straub 1996). However, Bedard *et al.* (2006) find that reviewers (managers) are less influenced by the ease of use (which is impacted by computer self-efficacy) of a system than are the preparers. They pose that the "greater importance of system efficiency among audit managers and partners is likely related to their accountability as senior officers." Thus, emerging technologies by definition will have lower IT self-efficacy, (a concept supported by this study), and in order to increase adoption, the usefulness and efficiency of the system needs to be made clear to senior managers to increase their adoption. One objective of this study was to initiate discussion, debate, and action that will lead to positive changes in the international auditing profession. We believe the information obtained provides a basis for moving in that direction.

Future researchers may wish to further investigate why the self-reported IT knowledge levels of certain technologies, such as test data, in Figure 2, load differently onto different constructs in different countries. Also, future researchers can measure whether, as an "emerging technology" matures, greater convergence will occur over time in factor analysis, as in the case of the more mature construct, General Office Automation (100% convergence) in Figure 2. Finally, this study provides a great basis and benchmark for other researchers to continue to study the IT skill levels of auditors worldwide. The required IT skills may change over time, and the systematic study and documentation of such changes across cultures is worthwhile. Comparing the composition of constructs over time and how different cultures "emerge" in their understanding of the underlying technologies could perhaps even help to predict, in the future, which "culture" or population may be best poised for the next generation of technological change.

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