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審計人員規劃存貨證據之過程與其判斷之研究

林文雄　Theodore J. Mock
Arnold M. Wright　Merrill J. Lewis

中文摘要審計的效率與效果，主要是係取決於所蒐集證據的性質及多寡程度；然而，針對審計人員從事審計規劃時，應如何進行此種複雜之判斷的文獻卻極少。本文以實驗的方式，對41位擁有豐富經驗的審計人員，就其規劃存貨證實測試時所做的判斷加以研究分析。結果顯示審計人員在衡量不同證據時，對審計文獻中曾提及之主要標準的相對重要性，均表現出極高的共識程度。明確地說，審計證據的適切性是最受重視的一項，其次是足夠性及蒐集證據的成本。電腦決策輔助組較判斷組重視適切性標準，而不重視成本標準；此差異可由審計時數的分配上得知。電腦決策輔助組比判斷組分配較多的小時數在分析性複核上，較少的小時數觀察存貨的實地盤點。從成本—效益的觀點和最近許多會計師事務所多採用分析性複核的趨勢來看，本文的研究結果顯示出使用電腦決策輔助，將會使審計人員花費較多的時間從事分析性複核，而花較少的時間執行其他類型的審計程序。但是，就本文所採用的研究個案而言（指審計時數的分配），各受試者間對電腦化多重標準決策輔助的評價，意見卻相當分歧。不過，審計人員卻都相信電腦決策輔助對研究、衡量證據品質的標準及各種審計程序的效率時，是一項極有價值的工具；此外，他們也認爲決策輔助工具相當易於使用。

林文雄為美國南加州大學教授
Theodore J. Mock為美國南加州大學教授
Arnold M. Wright為美國東北大學教授
Merrill J. Lewis為美國加州州立工技大學副教授

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AN EXAMINATION OF AUDITOR MULTIPLE CRITERIA JUDGMENTS IN PLANNING INVENTORY AUDIT PROCEDURES

Thomas W. Lin
University of Southern California

Theodore J. Mock
University of Southern California

Arnold M. Wright
Northeastern University

Merrill T. Lewis
California State Polytechnic University

Abstract

The efficiency and effectiveness of an audit depend primarily on the planned nature and extent of evidence, yet there is little research on how auditors make such complex judgments. This study examines the inventory substantive audit evidential planning judgments of 41 experienced auditors in an experimental setting.

The results indicate that auditors displayed strong consensus as to the relative importance of key criteria suggested in the professional auditing literature to weigh evidential alternatives. Specifically, competence was considered of greatest concern, followed by sufficiency

and cost of gathering the evidence. The computer-assisted decision aid groups placed greater weight on competency criterion and lesser weight on cost criterion than the judgmental groups.

Differences were observed concerning the appropriate allocation of audit time. The computer-assisted decision aid groups assigned more hours to analytical procedures and less hours to other tests than the judgmental groups. Considering the promising cost-effectiveness and the recent trend by many accounting firms towards analytical procedures, the findings here suggest that requiring a computerized decision aid may cause auditors to spend more time on analytical procedures and less time on other categories of audit procedures.

Finally, auditors believed the computer-assisted decision aid to be a valuable tool to systematically examine and focus upon important evidence criteria. The decision-aid was also seen as relatively easy to use.

1. Introduction

An audit entails the gathering and examination of evidence in order to express an opinion as to the fairness of a set of financial statements. It is well recognized that the quality of various types of audit evidence can differ significantly along several dimensions such as the relevancy and reliability. Additionally, the availability and cost of obtaining the evidence also vary considerably. An auditor must weigh these multiple qualitative and quantitative criteria in designing audit programs. The cost-effectiveness of an audit appears largely dependent on the choice of procedures and the allocation of time among these procedures. Failure to explicitly consider the costs and benefits of various procedures in audit planning will result in a less effective or efficient audit.

Surprisingly, there has been very little research on how auditors actually make the complex evidence choices required. Such research would seem to offer great promise in suggested preferred or improved ways to perform audit planning of procedures. Mock and Wright (1980) review the research in this area and conclude empirical research is greatly needed on the relative effectiveness of audit procedures. A framework, based on concepts of measurement theory, is advanced to guide such research. Felix and Kinney (1982) conduct a thorough review of the auditing literature and note

that "state-descriptive research on the auditor's initial planning process is nonexistent." They believe such research offers great promise.

The purposes of this paper are to: (1) identify the reliance placed by auditors on several key criteria in evaluating audit procedures; (2) examine the usefulness of a multiple criteria decision aid in assisting auditors in planning the allocation of audit time among different categories of audit procedures; and (3) compare the planned time allocations of auditors using the decision aid to those without access to the aid.

The rest of the paper is organized as follows: The next section identifies and summarizes the criteria for evaluating audit evidence from professional auditing standards. The third section describes a multiple criteria decision aid called the Analytic Hierarchy Process (AHP) for the evaluation of audit procedures. The fourth section discusses research questions and methodology. In section five, the experimental results are presented. The final section discusses the findings.

2. Criteria for Evaluating Audit Evidence

There have been a number of attempts to identify a set of criteria for use in the evaluation of audit evidence (see Mock and Wright, 1980 for a review and critique of the major works in this area); however, no definitive list has been established. In this paper, since practicing auditors will be used in the empirical study, a set of criteria based primarily upon pronouncements in the professional literature will be used.

There are various levels of criteria detail, or definitional fineness, at which the evaluation of audit evidence may be considered. The least fine set of criteria may include a single criterion, such as "persuasiveness," which collapses both quality and quantity considerations into a single dimension. On the other hand, in addition to the sufficiency and competency criteria suggested in the third standard of field work, AICPA Statement on Auditing Standards (SAS) No. 31 states that, to be competent, "evidence must be both valid and relevant." Relevance is not further defined in the SAS. However, we take it to mean "the pertinence of the evidence given the underlying audit objective." (AICPA, 1988).

Table 1 presents a summary of the AICPA literature on criteria for evaluating audit evidence procedures. There are two sets of criteria. Set A

includes three criteria of cost, competency, and sufficiency. Set B includes five criteria of cost, bias, reliability, relevance, and sufficiency. Note that bias, reliability, and relevance are a finer partitioning of the "competence" criterion. These two sets of criteria are used in our study for evaluating inventory audit evidence procedures.

3. A Multiple Criteria Decision Aid for the Evaluation of Audit Procedures

A multiple criteria decision aid is a computer-based system for modeling human judgment involving multiple criteria. The Analytic Hierarchy Process (AHP), developed by Saaty (1977, 1978, 1980), is a systematic, multiple criteria method for making unstructured decisions. This method is based on three major components (Saaty, Vargas, and Barzilay, 1982). First, a complex problem is decomposed into a hierarchy; each level consists of a few manageable elements and each element is, in turn, decomposed into another set of elements. The process continues down to the most specific elements of the problem, typically the specific courses of action considered, which are represented at the lowest level of the hierarchy. Second, a measurement methodology is used to establish priorities among the elements within each level of activity based on pairwise comparisons by the decision makers. And third, a measurement theory is used to establish the priorities of the hierarchy and the consistency of the judgmental data provided by the decision makers. This measurement theory uses matrix algebra to calculate a maximum eigenvalue and a normalized eigenvector. This eigenvector sums to 1.00 and measures the decision maker's relative trade-offs at each level of the hierarchy on an interval scale. The approach entails a linear, additive, compensatory model.

The analytic hierarchy process has been tested and applied to different multiple criteria decision problems such as choosing a job, selecting a political candidate, choosing a transport plan, and rationing energy to industries. In the accounting literature, Lusk (1976) applied it to evaluate prospective audit clients; Lin (1980) used it to select the best cost-volume-profit analysis under uncertainty model; Lewis and Patton (1980) showed its use in the analysis of alternative accounting policies; Jensen (1982) proposed an eigenvector model for elicitation and review of management

TABLE 1

Definition of Evidence Evaluation Criteria

SET A

1. Cost: The additional cost of obtaining the audit evidence which is being evaluated.

2. Competency: The overall quality of the audit evidence, which is based on two general factors:

   a. accurate measurement (valuation) resulting from lack of bias (preparer influence) and reliability (accurate accounting system) and

   b. relevance: the pertinence of the evidence to the audit objective examined.

3. Sufficiency: The quantity or "weight" of evidence relative to what is needed to satisfy audit objectives. Audit evidence is usually considered sufficient if it is persuasive rather than convincing.

SET B

1. Cost: The additional cost of obtaining the audit evidence which is being evaluated.

2. Bias: The amount of error or misstatement in audit evidence which may result from preparer influence (e.g., management).

3. Reliability: The amount of error in audit evidence which is a result of inaccuracies in measuring and compiling data.

4. Relevance: The pertinence of the evidence to the audit objective examined.

5. Sufficiency: The quantity or "weight" of evidence relative to what is needed to satisfy audit objectives. Audit evidence is usually considered sufficient if it is persuasive rather than convincing.

forecasts; Arrington et al. (1984) applied it to model expert judgments on analytical review procedures; Boritz and Jensen (1985) showed its use in planning audit evidence-gathering process; and Harper (1988) used it in internal control evaluation.

The major advantages of the AHP method are: (1) it offers a flexible modeling and measurement approach to the evaluation of the strategies under alternative competitive scenarios; (2) it offers a procedure for using data and requires strict independence, ordinality, or homogeneity; (3) it is easily comprehended by respondents, exhibits highest/retest reliability scores, and is useful in a group setting (Saaty, 1980). The limitations of this method include: (1) it assumes a linear, additive, and compensatory model structure whereas human preference is often neither linear, additive, nor compensatory, and (2) it does not consider judgmental heuristics and biases.

We developed an on-line interactive AHP computer system as a decision aid for the purpose of our empirical study. This AHP computer system has the following steps:

1. The auditor identifies m alternative audit evidence gathering procedures and n different evaluation criteria.

2. Through empirical testing or subjectively, the author conducts pairwise judgment comparisons of criteria with respect to overall satisfaction with the evidence collection alternatives. The purpose of this step is to elicit judgments from an auditor concerning the relative importance of the various criteria. Assessments of relative importance are obtained by pairwise comparison judgments using a scale of 1 to 9. Suppose the auditor has n criteria $A_1, \ldots, A_n$, and n relative subjective weights $W_1, \ldots, W_n$. A matrix of pairwise comparisons of weights may be constructed (where the entries indicate the strength with which one element dominates another with respect to a given criterion):

$$A = \begin{array}{c} \\ A_1 \\ \vdots \\ A_n \end{array} \begin{array}{c} \begin{array}{ccc} A_1 & \cdots & A_n \end{array} \\ \begin{bmatrix} W_1/W_1 & \cdots & W_1/W_n \\ \vdots & & \vdots \\ W_n/W_1 & \cdots & W_n/W_n \end{bmatrix} \end{array}$$

This matrix has positive entries in every cell and should satisfy the reciprocal property: $a_{ij} = 1/a_{ji} = W_i/W_j$

Each criterion must be compared to all others by ranking them using the following scale: (That is, when the element on the left side of the matrix is compared with an element on top, how much more strongly does it have the property in question?)

SCORE	DESCRIPTION
1	A_i and A_j are equally important.
3	A_i is slightly more important than A_j.
5	A_i is materially more important than A_j.
7	A_i is significantly more important than A_j.
9	A_i is absolutely more important than A_j.

The numbers 2, 4, 6, 8 represent intermediate values between each of the above numbers. If the comparison of A_1 (row) to A_2 (column) yields a score of 5, a 5 is entered in the first row, second column of the matrix to represent W_1/W_2. The reciprocal is also entered into the opposite element in the array. Thus, the value of 1/5 would be placed in the second row, first column to represent W_2/W_1.

3. The computer system calculates the maximum eigenvalue $\lambda_{max}W$ and derives the normalized eigenvector E of matrix A. One can recover the scale of weights $W_1, \ldots, W_n$ by multiplying A on the right by W, obtaining nW, and then solving the eigenvalue problem $AW = nW$, which has a nontrivial solution since n is the largest eigenvalue of A. The matrix A has unit rank; hence all but one of its eigenvalues $\lambda_2, \ldots, \lambda_n$ are zero. Since $\sum_{i=1}^{n} \lambda_i = \text{trace } (A) = n$, n is the maximum eigenvalue. One can then derive the principal eigenvector of matrix A by solving the problem $AW = \lambda_{max}W$.

The elements of the normalized eigenvector E based on the maximum eigenvalue can be used as interval scale measures of the auditor's perceived relative importance (weight) of the criteria.

4. The auditor conducts the same pairwise judgment comparison for each of the m audit evidence procedures with respect to each of the n criteria.

5. The computer system derives the normalized eigenvectors for the above matrices and checks the consistency of the weights and adjusts the values of the normalized eigenvector for inconsistent weights using the method developed by Lusk (1976).

6. The computer system forms these n normalized eigenvectors into a new matrix call B which represents the relative weights of various audit procedures on different criteria.

7. The decision aid obtains the overall ranking and weighting of those m audit evidence procedures by multiplying the B matrix on the right to the transparent of the vector E of the weights of the n criteria. This yields a column vector R with normalized values of m elements which represent the final value of each of the m audit evidence procedures. This is a linear, additive, compensatory model of the composition (aggregation) of multivariate performance and importance.

8. The auditor can select the procedure with the highest value, use the rankings as a guide to allocate available audit resources, or conduct additional sensitivity analysis.

4. Research Questions and Methodology

4.1 Methodology

Forty-one auditors from Big 6 accounting firms participated in the study. Participants possessed an average of 4.8 years of audit experience. Seventy-six percent were either supervisors or managers, twenty-four percent were seniors.

Auditors were provided a comprehensive, realistic case in the inventory area ("Modern Appliance Manufacturing Co.") and were asked to evaluate alternative evidential sources along various key criteria for the inventory account. Subjects then decided which evidence to focus on by allocating a time budget of 150 hours to three broad evidential categories of inventory audit procedures: analytical review, physical observation, and detailed tests. (The actual planned substantive audit program in each category was provided).

As a common frame of reference, the case provided illustrative audit programs for each evidential category of inventory audit procedures. Since there are numerous procedures that may fall under each of these categories, it was believed that a benchmark program was necessary to reduce confusion and to avoid serious confounding of the results. The audit programs provided were developed with the consultation of practicing auditors and

were later pilot tested. The inventory audit procedures appear to be representative of widely- used tests for a manufacturing client with strong controls, as in the case here. To maintain task simplicity and minimize required subject time, the study examined audit planning judgments for these three major evidence categories rather than the selection of detailed individual audit procedures.

The Modern Appliances case contained extensive background information necessary to plan substantive tests. First, information was provided on the engagement and financial data, including product lines and comparative financial statements. Second, the inventory/purchases internal control system was described in detail, reflecting an environment of strong controls. Compliance tests further revealed that controls were functioning properly.[1]

Subjects were randomly assigned to one of the four experimental groups as indicated below:

Evidence Criteria Considered	No Decision Aid: Judgmental (D_0)	Decision Aid: AHP(D_1)	Total
3 Criteria (C_3)	10	10	20
5 Criteria (C_5)	11	10	21
Total	21	20	41

Note: Data indicates numbers of auditors under each conditions

Auditors were asked to focus on the following evidence criteria:

3 Criteria	5 Criteria
Competency	Relevance
Sufficiency	Bias
Cost	Reliability
	Sufficiency
	Cost

As discussed earlier, relevance, bias, and reliability were seen as a further partitioning of competency. Definitions of each criterion were provided to subjects as indicated in Table 1.

[1] A copy of the complete case may be obtained from the authers upon request.

In considering the criteria, auditors made two sets of judgments for the case: (1) establishing the relative importance of each criterion, and (2) evaluating the three evidential choices along the various criteria. For example, a subject would first assess the relative importance of the criterion, "cost of gathering the evidence" as compared to other criteria. Then, he or she would evaluate the merits of the three categories of the inventory audit procedures for each criterion. "In terms of cost, which evidence (analytical procedures, physical observation, or detailed tests) is preferable?" Two groups of subjects used the Analytic Hierarchy Process (AHP) decision aid while the other two groups relied upon professional judgment to arrive at both of these judgments.

Evidential planning decisions are, thus, viewed as a function of the relative weighting placed on selected criteria and the judged superiority of alternative sources of evidence on each of these criteria. Finally, subjects planned the allocation of 150 audit hours (resource allocation) for the three alternative procedure categories (evidence sources). Subjects were allowed to take whatever time was needed to complete the task and anonymity was guaranteed.

4.2 Research Questions

Five major research questions were examined in this study:

1. What relative weights do auditors place on the criteria suggested by the professional auditing literature?
2. What is the impact of the decision aid on criteria weightings?
3. What affect does the decision aid have on auditors' resource allocation decisions?
4. What is the relationship between AHP weightings and the auditors' resource allocation decisions?
5. How useful is the AHP computer system as an decision aid?

5. Analysis of Results

5.1 Relative Importance of Evidence Criteria

To answer the first research question, Table 2 presents summary data on the relative mean weighting by each group of the evidence criteria examined. The partitioning of the criterion "competency" into three elements (bias, reliability, and relevance) seems to be reasonably valid as evidenced by comparing the relative mean weightings of the experimental groups:

Relative Mean Weighting	Judgmental	Computer-Assisted
Competency	.45	.63
Partitioning (total weights= bias + reliability + relevance)	.58	.71

The order of significance for the three criteria groups was: competence, sufficiency, and (a distant third) cost. These preferences are in agreement with the professional auditing literature (SAS No. 31); i.e., competence and sufficiency are paramount, with cost a secondary consideration.

The order of significance for the five criteria groups was: relevance, sufficiency, reliability, bias, and cost. Therefore, both three and five criteria groups displayed consistent responses reflecting relevance/competency as the most important evidential quality, while cost of gathering evidence was considered a secondary factor. Sufficiency fell in the middle.

To further investigate whether there are significant differences in the criteria weighting between groups D_o and D_1, i.e. to answer research question No. 2, a MANOVA was conducted. Table 3 contains the results of the MANOVA analyses, which indicate significant differences were found. Specifically, for subjects who evaluated 3 criteria (C_3), an examination of mean responses (Table 2) reveals that the judgmental group (D_o) weighed cost as more important than the decision aid (computer-assisted) group (D_1). The D_1 group correspondingly placed greater weight on competency. A similar pattern appears for participants faced with 5 criteria (C_5). Again, the judgmental group placed more importance on cost than the computer-assisted group. The computer-assisted group put more weight on the criteria of bias, reliability and relevance, which represent a partitioning of competency. D_1 auditors particularly emphasized relevance more than D_o auditors.

5.2 Allocation of Audit Time Among Procedures

TABLE 2
Relative Mean Weighting of Evidence Criteria

	Criteria					
Group*	Cost	Sufficiency	Competency	Bias	Reliability	Relevance
D_o, C_3	.24	.31	.45	—	—	—
D_1, C_3	.11	.26	.63	—	—	—
D_o, C_5	.16	.26	—	.14	.18	.26
D_1, C_5	.05	.24	—	.15	.20	.36

*D_o = Judgmental
D_1 = Computer-Assisted (AHP)
C_3 = 3 Criteria Weighted (cost, sufficiency, competency)
C_5 = 5 Criteria Weighted (cost, sufficiency, bias, reliability, relevance)
Note:

Response scale 0 - 1.00 = $\frac{\text{allocated points for criterion}}{\text{100 total available points}}$

This measure is an indication of the perceived importance of each criterion.

Judgmental subjects provided this allocation of points directly. Weights for Computer Assisted subjects are calculated from paired comparisons made among criteria using the AHP interactive computer system.

TABLE 3
Manova: Evidence Criteria Weightings of Importance–Judgmental vs. Computer-Assisted Subjects

Groups*	Approximate F	Hypothesis df	Error df	Significance of F
D_o, C_3 vs. D_1, C_3	4.856	3.00	17.00	.013
D_o, C_5 vs. D_1, C_5	1.896	5.00	14.00	.159

*D_o = Judgmental
D_1 = Computer-Assisted (AHP)
C_3 = 3 Criteria Weighted
C_5 = 5 Criteria Weighted
Note: Tests of significance based on Wilks Lambda Criterion.

To answer the third research question, Table 4 provides data on the allocation of the time budget of 150 hours among the audit procedures. A MANOVA indicated significant differences in time allocations between the four experimental groups (see Table 5).

The direction and magnitude of differences are suggested by the mean responses provided in Table 4. In general, the computer-assisted (AHP) group appeared to assign more hours to analytical procedures and less hours to observation than the judgmental group. However, the judgmental group made up of 3 criteria subjects (D_o, C_3) arrived at time allocations that substantially deviated from all others. (See the MANOVA results in Table 5). This experimental group allocated a greater percentage of time to detailed tests and less time to analytical procedures than all others. The auditors in this group were provided with the least amount of structure and guidance.

Based upon the findings of this study in the inventory area, it appears that requiring auditors to focus on *additional criteria* (partitioning) or using the *AHP approach* may have a significant impact on altering the time allocations of detailed tests vis-a-vis analytical procedures, i.e., greater emphasis on analytical procedures. If such a shift in resources is considered desirable by a consensus of firm partners, the findings here suggest that greater partitioning of criteria and/or the AHP approach may be useful in directing auditors to focus efforts appropriately. However, the case provided in this study involved a client with strong internal controls. Time allocations among experimental groups in a weak control situation are not examined. Therefore, the results only relate to a strong control environment and further research is needed to extend the analysis to other control situations.

5.3 Comparisons of AHP Suggested Time Allocation to Auditor Allocations

The final output of the AHP computer system is an overall ranking of each audit procedure area based upon the comparisons for each procedure along the criteria. These rankings provide useful information for resource allocations such as assignment of audit hours. Subject to the limitations of the AHP discussed earlier, the overall rankings may be viewed as normative guidelines for time allocation, since the rankings accurately map the

TABLE 4
Allocation of Audit Hours

	Audit Procedures						
	Analytical Review		Observation		Detailed Tests		
Group*	Mean	S.D.	Mean	S.D.	Mean	S.D.	Total Hours
D_o, C_3	25.0	18.9	46.4	13.4	78.6	25.0	150
D_o, C_5	42.0	22.3	47.6	23.2	60.4	25.1	150
D_1, C_3	46.4	19.4	39.3	14.3	64.3	28.7	150
D_1, C_5	40.0	20.1	38.5	19.4	71.5	31.1	150

*D_o = Judgmental

D_1 = Computer-Assisted (AHP)

C_3 = 3 Criteria Considered

C_5 = 5 Criteria Considered

Note:

Response scale = 0 - 150 hours

Represents 150 available audit hours that subjects allocated among the three audit procedure categories.

TABLE 5
Manova: Allocation of Audit Time by Experimental Groups

Source*	Wilks Lambda	Approximate F	Significance of F
D	.00423	2745.047	0.00
C	.00382	3038.859	0.00
$D \times C$	.00395	2939.038	0.00
Residual	.00043		

*D = Presence of decision aid (Judgmental vs. Computer-Assisted)

C = Number of criteria considered (3 or 5 criteria)

Note: df = 3 (effects), 35 (error).

TABLE 6
Auditor Allocation of Audit Time
vs. Computer-Suggested Allocation

Computer Assisted AHP Group (D_1)	Analytical Review		Observation		Detailed Tests	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
3 Criteria-Auditors (C_3)	.31	.13	.26	.09	.43	.19
-Computer	.35	.18	.34	.20	.31	.19
5 Criteria-Auditors (C_5)	.26	.13	.26	.13	.48	.21
-Computer	.26	.15	.36	.17	.38	.15

Note:

Response scale = 0 - 1.00, represents percentage of audit hours allocated to each procedure (1.00 = 100%). The responses labeled "Computer" indicate the recommended allocation of audit resources based on the output of the Analytic Hierarchy Process employed.

auditor's preferences as to criteria weightings and paired comparisons of each procedure. How did the allocations of individual auditors using the computer system (D_1) compare to the suggested AHP allocations? (i.e., Research Question No. 4).

Table 6 provides summary data on this issue. The findings for the C_3 and C_5 groups demonstrate that auditors seem to allocate a substantially greater proportion of time to detailed tests than indicated by the AHP suggested overall rankings and a lower proportion of time than suggested by AHP for observation. Allocations for analytical review time were generally consistent with that noted by the rankings. Further analyses were performed, since the results in Table 6 are restricted to only aggregate summary measures (mean responses).

The Pearson correlation coefficients between individual auditor time allocations and AHP allocations are reported in Table 7. At the individual level, the findings do not support the conclusions apparent in the aggregate data. Since there is not a normative solution available as to the "correct"

allocation of time among procedures, the appropriate comparison should be between that individual's AHP ranking and the final allocation judgment.

The correlation coefficients in Table 7 suggest that auditors considering 5 criteria departed more from AHP allocations than those facing 3 criteria. One can speculate that perhaps the greater complexity and difficulty of weighing 5 criteria simultaneously account for the lower correlations found. Auditors may have resorted to heuristic rules in such a complex decision setting. The greater level of agreement between 5-criteria judgmental and computer-assisted auditors (D_o, C_5 and D_1, C_5) than the comparable 3-criteria groups (D_o, C_3 and D_1, C_3), as noted in Table 4, provides corroborating evidence for this view. The use of heuristics would appear to be most prevalent among judgmental subjects, who do not have the benefit of a decision aid such as the AHP. If this explanation for the lower correlation coefficients found among the D_1 and C_5 participants is accurate, there appears to be a strong need for the structured AHP approach for difficult judgment situations to serve as a guide for auditors.

Contrary to aggregate findings, auditor's time allocations for detailed tests were quite close to that suggested by the individual AHP rankings; that is, they have high correlation coefficients of 0.76 and 0.74 for 3 and 5 criteria groups. The 5 criteria group displayed considerable discrepancies between the proportion of time indicated by the AHP system for observation and actual allocations (correlation coefficient of 0.14).

5.4 Usefulness of the AHP as a Decision Aid

To answer the last research question, Table 8 indicates the perceptions of auditors on the usefulness of the AHP computer system as a decision aid. There was disagreement on the value of the AHP, specifically for the task in the experiment, with the majority of auditors feeling the computer system was of marginal help. However, participants did believe the AHP approach is a valuable tool to systematically examine and focus upon important evidence criteria. Further, only 14% of the respondents felt the AHP computer system was hard to use. A series of Chi-square tests revealed no significant differences ($p \leq .10$) in the beliefs of those facing 3 and 5 criteria (D_1, C_3 vs. D_1, C_5) on all the questions summarized in Table 8 except for ease of use. For this latter question, the χ^2 was equal to 8.67

TABLE 7
Correlation between Individual Auditor Time Allocation and the Suggested AHP Allocation

Audit Procedure	3 Criteria	5 Criteria
Analytical Review	.57	.41
	($p = .03$)	($p = .12$)
Observation	.59	.14
	($p = .03$)	($p = .35$)
Detailed Tests	.76	.74
	($p = .003$)	($p = .01$)

Note: Data above are Pearson Correlation Coefficients.

TABLE 8
Perceived Value of the Analytic Hierarchy Process Computer System

		% of Respondents				
	Question	Extremely Valuable		Helpful		of Very Little Help
1.	How valuable did you find this computer system in helping you to decide how to allocate audit time?	0%	14%	34%	38%	14%
	Evaluate the value of the computer system as:					
2.	A systematic way to examine all relevant considerations of quality and efficiency.	5%	24%	33%	29%	9%
3.	A way to make one focus on important criteria in the quality and efficiency of various procedures.	14%	14%	43%	24%	5%
		Extremely Easy to Use		Neither Overly Easy or Difficult		Very Difficult to Use
4.	Evaluate the AHP computer system's ease of use	24%	38%	24%	9%	5%

and was marginally significant ($p = .07$). For no discernible reason, the 5 criteria group perceived the AHP computer system to be easier to use than the 3 criteria group; 100% found it "easy to use to neither overly easy or difficult" in C_5 group vs. 73% for the C_3 group.

In summary, participants had difficulty in perceiving the direct usefulness of the AHP computer system for the task at hand. However, the value of examining several relevant evidence criteria in a structured manner was recognized. Perhaps the less-than-enthusiastic appreciation for the AHP computer system for the specific task of time allocation can be traced to the lack of prior exposure subjects had in actual application of the AHP. It must be recalled that this experiment was the first time any of the subjects worked with this interactive computer decision aid. Additionally, computerized decision aids such as the AHP are often threatening, leading to the presumption that the approach will usurp decisions now made by the individual. Alternately, the AHP computer system may be of greater benefit for other audit judgments such as the global planning decision of allocating total engagement hours in account areas such as accounts receivable, inventory, and property. Experimentation on the usefulness of AHP for various audit tasks is needed and encouraged.

6. Discussion and Conclusions

The results of this experiment suggest that the AHP approach significantly affects auditors' weightings of importance on various evidence criteria. Audit effort among procedures, as represented by time allocations, are also substantially affected. Table 2 shows that subjects using the AHP (D_1) placed greater weight on competency and relevance and less on cost than the judgmental group (D_o). Table 4 indicates that greater audit time was generally assigned to analytical procedures by D1 auditors and less to inventory physical observation. This shift in audit hours to analytical review appears consistent and logical with the increased focus on the criterion of relevance by AHP subjects. Analytical review is generally viewed as a highly relevant form of evidence in uncovering material financial statement errors. The findings by Wright and Ashton (1989) and Hylas and Ashton (1982) suggest that analytical procedures are highly cost-effective in identifying audit adjustments. In light of these early findings, the AHP

approach appears promising in focusing auditors on cost-relevant trade-offs and encouraging greater reliance on analytical procedures.

Despite the increased general emphasis on analytical procedures, Table 6 shows that D_1 auditors allocated more time to detailed tests and less time to analytical procedures and observation than suggested by computer generated AHP guidelines. The deviations from AHP norms were slightly more pronounced for the complex 5 criteria decision setting. To the extent that AHP rankings can be viewed as normative benchmarks, the findings reported here suggest the AHP approach is needed to provide guidelines for the efficient and effective allocation of audit time among procedures. To be of optimal usefulness, auditors must become familiar with the approach and learn to appropriately weigh the guidelines provided by this decision aid as an important input to the time allocation judgment.

Finally, Table 8 indicates that the AHP computer system was found to be reasonably well accepted by participants as a useful tool to structure and focus evidence assessment decisions, even though the majority felt the approach was of limited direct usefulness for the specific time allocation task. The interactive AHP computer system was also considered to be relatively easy to use. The level of acceptance appears to be quite high when considering that the experiment was the first exposure for subjects to this unfamiliar, somewhat threatening computerized decision aid. Research is needed to examine subject acceptance with repeated and on-the-job use of the interactive computer system.

Due to the exploratory nature of the present study, there are avenues for future research to extend this research work. A constraint of the experiment was that auditors were provided a fixed time budget of 150 hours and asked to allocate available hours to audit procedures. Thus, there is no evidence of whether *total* planned hours would differ between judgmental and AHP subjects. Given the greater focus on analytical procedures by AHP auditors, one may hypothesize that total hours may be lower for this group as the perceived effective review procedures are traded for greater hours of detailed tests. Of course, the cost per hour varies by procedure and analytical procedures may require greater experience. A similar experiment to the present one allowing auditors to indicate hours needed for each procedure would provide valuable evidence on the effect of the AHP approach on overall audit costs and efficiency.

The AHP may be useful in aiding auditors to structure many types of decisions. This study investigated the time allocation judgment among procedures. A promising extension to the present experiment would be to examine the value of the AHP approach in allocating the total hours on an engagement to account areas. In open-ended remarks, several subjects noted that they felt the approach would be of greater usefulness for time allocations among accounts rather than among procedures. The assignment of efforts to account areas determines the overall risks and effectiveness of the audit process. The value of the approach for other audit decisions also may be explored, such as internal control judgments.

The usefulness of the AHP for auditor training and auditing education also appears to be a fruitful area of research. AHP may be employed in staff training sessions to make auditors aware of the considerations and trade-offs present in planning audit procedures and time allocations. The approach also would seem to be helpful in auditing classes to focus students on the issues and complexity of designing audit programs.

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