

# Discussion of Information System Assurance for Enterprise Resource Planning Systems: Implementation and Unique Risk Considerations

(Pending response  
to Q1 for Wright  
and Wright)

## When and How Do We Use Heterogeneous Expert Opinion as a Basis for Research on ERP Systems?

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**ABSTRACT:** Asking experts their opinion is an important methodology in those settings where the major issues have not been previously addressed, often early in the topic's research life cycle. Heterogeneous expert opinion (HEO) refers to gathering the opinion of experts that derive from a number of categories, e.g., partner, manager, and senior, or whether they are accountants or computer scientists. They are heterogeneous in that they are recognized as having different levels and/or types of expertise. Research of enterprise resource planning (ERP) systems must carefully examine expert opinion and determine when using HEO is appropriate and when it should be stratified. In addition, where possible, previous research needs to supplement or be compared to the HEO to determine similarities and differences with other groups.

### I. INTRODUCTION

Enterprise resource planning (ERP) systems, as their name indicates, can impact the entire enterprise. Doing research on enterprises is not easy. It is a much easier task to analyze a research study (or even multiple studies) and criticize it (them), than it is to do ERP research.

#### Purpose

The purpose of this paper is to do a detailed analysis of Wright and Wright (2002) and generalize the findings. Wright and Wright's goal was to "obtain an understanding of the unique risks associated with the implementation and operation of ERP systems." In addition, they were interested in providing an empirical analysis of risk considerations for ERP systems. Using a semi-structured interview form the authors taped discussions with the 30 participants, 10 from each of three Big 5 firms. The interview form had seven open-ended questions that were asked of the participants, of which data from six were reported. Participants were specialists from the consulting organizations. Participants' comments were coded and then ranked by reported frequency. The focus here is on the questions and responses to those questions. As a result, the tables and responses in this paper, unless otherwise specified, come directly from Wright and Wright.

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I thank J. Efrim Boritz for providing the incentive to review this paper in detail.

Wright and Wright employed what will be referred to as “heterogeneous expert opinion” (HEO). Participants were purported to be “experts,” but they came from at least three different levels in the Big 5 firm: Partner, Manager, and Senior, and from accounting and systems backgrounds. As a result, the level of expertise is “heterogeneous,” since multiple levels and types of expertise were involved. It is opinion, since the questions asked of the participants gathered their opinions. Wright and Wright use HEO gathered from relatively unstructured interviews to make some assertions about risk and security in ERP systems.

Wright and Wright is not the only ERP-based research to use HEO or some related approach. Increasingly, I find that researchers are asking “experts” their opinion as a methodology to try to get to some ERP topics. For example, I know of studies where the researchers have chosen a number of companies and are interviewing one or more “experts” at those companies in hopes of gaining insights about the ERP implementations at those companies specifically, and in general. As a result, a similar set of comments could be potentially directed at other studies that make substantial use of HEO in similar ways.

### This Paper

This paper proceeds in the following manner. Section I laid out the basic notion of HEO, establishes the purpose and the basic plan of the paper. Section II examines some of the previous research in ERP systems. Sections III–IX each comment on the data on the participants, the questions, and the findings. Section X summarizes the key comments and findings of this paper. Section XI directly addresses the issue of when and how to use HEO, based on the findings.

## II. PREVIOUS RESEARCH

What kinds of methodologies have been used in the area of ERP systems? There have been a large number of surveys capturing a wide range of information about ERP systems, a number of which have been summarized in O’Leary (2000). Von Everdingen et al. (2000) did a large-scale survey of almost 3,000 firms to investigate ERP adoption by European firms.

Other researchers have developed cases for both research and teaching purposes. For example, Soh et al. (2000) did an investigation of one public hospital’s implementation, using documents and interviews. Markus et al. (2000) used a number of cases in their research to tease out a better understanding of multi-site implementations. As an example of a teaching case, Cottle et al. (1998) discuss Cisco’s ERP implementation. Q3

Kremers and van Dissel (2000) used HEO to gather data based on ERP system migrations. Using semi-structured interviews they asked “why” the firm migrated to a new version and what problems they had with the migration.

Particular issues of ERP risk were examined in O’Leary (2000), including the impact of the ERP life cycle on discerning risk issues. Further, a survey that addressed parameters associated with some key ERP problems was summarized.

## III. DETAILED ANALYSIS OF DATA ABOUT “EXPERTS”

What follows is a listing of data from Wright and Wright about the experts and some comments on the data.

Title	%
Partner/Director	18.2
Manager	63.6
Senior/Consultant	13.7
Missing	4.5

“Partners” are generally recognized to have significantly greater expertise and experience than either “Managers” or “Senior” accountants. Managers are generally conceded as having greater expertise than Senior accountants. The title “Senior” would indicate some experience, but still would be seen as a position of limited expertise. With this range of expertise, the sample is one of heterogeneous expertise.

Unfortunately, the titles do not include the term “Senior Manager,” which the Big 5 use as a gradation between Manager and Partner. It is unclear if there are no Senior Managers or if they are aggregated with the other Managers.

Further, the job title “consultant” typically is a title that really means “no experience.” For the Big 5 it typically has been seen as a “beginner” position.

As a general comment, I am concerned over the accuracy of the data. For example, it was reported that there were 30 respondents and that one subject failed to identify his/her title. This would indicate 3.3 percent and not 4.5 percent for “Missing.” Such an error seems a bit high to attribute to rounding. There are similar concerns for all of the percentage data.

Work Experience	Years			%
	High	Low	Mean	
Accounting/Auditing	22	0	7.333	68.2
Information Systems/Computer Science	25	0	8.778	81.8
Other	2	0		13.6
Accounting/Auditing and Computer Science	25	4	11.083	54.5

In each of the two individual categories “Accounting/Auditing” and “Information Systems/Computer Science” the low for experience is “0.” As a result, it looks like the authors are compiling information from experts with zero years of experience. Clearly, if the paper is to reflect expert opinion the participants should be experts with more than zero years of experience.

Information systems and computer science often are taught in different schools. Information systems typically is taught in a business school, while computer science typically is a part of engineering. Further, the content of those programs can differ substantially. As a result, I don't think that the two provide a homogeneous category.

As with the previous data category some of the numbers do not reconcile to the text. For example, 54.5 percent of 30 is 16.35 people. On the other hand, for 16 of 30 people we would expect  $16/30 = 53.3$  percent, clearly different than 54.5 percent. Accordingly, the data is anomalous.

### Experience in ERP (Years)

The ERP revolution really started with SAP's R/3 release in Europe in 1992 and the U.S. in 1993. As a result, what does it mean to talk about “15” years of experience? What does that refer to? Does it refer to experience with mainframe versions? If so, then issues of problems, security, and controls are likely to be different because of the difference in computing environment. Does it refer to legacy systems? Is this a case of “consulting credentials,” where “more” is always better and customers never ask what “more” means? In any case this is anomalous and deserves investigation.

In addition, the lower bound of “1” is not an indication of expertise. There is concern about the aggregation of such a wide range of heterogeneous expertise.

Further, when this data is combined with other data it can yield questionable conclusions. At the low end, what does it mean to have “0” years of work experience and “1” year of ERP experience?

Specific ERP Experience	%
SAP	86.4
Oracle	59.1
PeopleSoft	58.1
JD Edwards	40.9
Other	9.1
Two or More Packages	77.3

About 22 percent of subjects have experience with only one package. However, subjects are asked two questions (2 and 3) that require comparison between different ERP systems. As a result, it seems that only those with experience in two or more packages should be presented as evidence for those questions. Yet the percentages are clearly based on the same totals for each of the questions.

Again, there are some problems with the numbers that do not go away with assumptions of rounding. For example, 18 and 17 people yield  $18/30 = 60$  percent and  $17/30 = 56.67$  percent, neither of which would be approximated to 59.1 or 58.1.

#### IV. QUESTION 1

**What are the biggest problems/issues frequently faced when implementing ERP systems?**

Life Cycle Stage	Problem	Reported Frequency (%)
(D)	Users were not adequately involved in the design of the ERP system.	68.2
(T)	Users were not adequately trained to use the ERP system.	40.9
(D/I)	Process reengineering was required.	40.9
(D/I)	The ERP system initially lacked adequate controls.	31.8
(D)	The ERP system was poorly designed; it did not adequately mirror required processes.	22.7
(I)	Systems implementation was poorly executed.	22.7
(D)	The ERP system as designed did not provide information needed to do the task (task-technology fit).	18.2
(I)	Data conversion was poorly executed.	18.2

D = Design; T = Training; I = Implementation

#### What "Problems" Have Previous Researchers Noted?

Previous researchers using the same basic approach have examined a similar question. For example, Kremers and van Dissel (2000) found the following list of "problems" for ERP migrations using an open-end question telephone survey of 24 Baan system owners.

##### Problems Encountered with Migrations of ERP Systems

Problem	Mentioned (%)
Time needed for implementation	50
Technical problems with new version	31
Bad estimates by migration partners	25
Costs involved	25
Strain on the organization	25
Quality of the migration support	25

Comparing lists between groups can provide some potential insights. For example, based on Wright and Wright (2002) we see consultants view users as the source of problems, whereas as seen in Kremers and van Dissel (2000) migration partners (including consultants) seem to be a major concern (e.g., "quality of migration support" and "bad estimates by migration partners").

Similarly, time, cost, and other factors show up on this list but not Wright and Wright (2002). When companies discuss problems with ERP system implementations it generally involves one of the following problems (O'Leary 2000):

- Budget Over-Run
- Time Over-Run
- Lack of Benefit
- Meets or does not meet business plan criteria

**Q4** For example, Philip Knight (2001) the chairman of Nike, in press coverage of Nike's ERP problems commented, "I guess my immediate reaction is 'This is what we get for \$400 million?'" (Songini 2001a).

However, the generated list of problems by the participants in Wright and Wright (2002) did not include any of these issues.

These last four issues are of concern to management, and hopefully consultants. I have talked to consultants who indicated that these last four were the critical issues. In addition, in the area of controls and security these are key problems. It is when there is a budget over-run or a time over-run that systems get “slammed in,” resulting in system implementations where there is no time or budget to build in security and controls are not fully implemented.

### **What Portions of the Life Cycle Are “Problems”?**

I have added the life cycle stage to the authors' information above. The problems listed by Wright and Wright (2002) roughly correspond to three different stages of the ERP life cycle.

As outlined in O'Leary (2000), one model of the ERP life cycle has six stages:

1. Deciding to Go ERP (Business Case Stage)
2. Choosing an ERP System
3. Designing an ERP System
4. Implementing an ERP System
5. After Going Live
6. Training

The problems isolated by the experts did not include problems from stages 1, 2, or 5. It is arguable that making sure that ERP is appropriate and choosing the right software that meets an enterprise's needs are the most important decisions. They are the foundation on which the other stages are built. This suggests that the “experts” have had limited experience with at least stages 1 and 2. These experts have chosen problems that probably are characteristic of “worker bee” problems. That is, much of the participant sample appears to have had experience in design and implementation, but not choice or business case. This is consistent with the sample that included less than 20 percent at the partner/director level. The bias in the sample can impact the findings and the corresponding rankings.

### **Problems with Users? What Is the Real “Problem”?**

By 27.3 percentage points, the biggest problem mentioned is a lack of participation by the users (client). On the other hand, users were not trained. What is typical of engagements where users are not involved or trained? These are likely to be scenarios where there is not sufficient “buy-in” regarding the system or sufficient management support or both. Thus, at one level, the “real problems” are the lack of buy-in and support, and the manifestations of those problems include a lack of user involvement and training. This illustrates that the view of the problem depends on the “experts” that have been chosen and how they are represented in the sample.

### **“Process Reengineering Is Required”**

In a tie for the second leading “problem” was “process reengineering was required.” This is a bit disconcerting. For example, Hammer (1997), the “father of reengineering,” indicated “SAP implementation equals forced reengineering.” Similarly, a vice president of Cap Gemini indicated (Gendron 1996) “it's rare when you don't have to do some kind of reengineering.” As a result, we would expect that reengineering would be a part of virtually all ERP implementations. If the experts did not expect that process reengineering was required that would force us to question their expertise. Thus, it is not clear what it means that 40.9 percent of the experts indicate that “process reengineering is required” is a major problem.

### **So, Who Said These Were Problems?**

Given a group of Partners, Managers, and Seniors, I would like to determine what the most expert group thought. In addition, I would like to know what the computer scientists thought were the biggest problems. As it stands, the primary thrust behind any given problem could be the “Manager-Accountant” group. The authors should stratify the expertise, and then analyze the relationships between the different segments.

### What Did We Learn That Was New?

Perhaps what is new is what we can gain from an analysis of perspective. Researchers (e.g., O’Leary 2000) have recognized the importance of implementation compromises that lead to difficulties after going live. However, based on this discussion we see that groups of auditor experts appear to have different answers than management groups.

This point is further illustrated by the importance of the lack of controls, in fourth place at 31.8 percent, that seems to be reflective of the fact that the job of the participants is to analyze security and controls. Yet, it seems almost certain that substantial concern for controls would have been predictable from this population. Given the bias in the population, the lack of emphasis on controls as a problem, may suggest that ERP system controls largely are effective and the extent to which controls are a problem is limited.

### What Does the Relative Ranking of “Problems” Mean?

What does the relative ranking of problems mean? For example, 68.2 percent asserted that “Users were not adequately involved in the design of the ERP system”? What does it mean—that 31.8 percent of the users did not mention the issue? Does it mean that they disagreed? In an unstructured questionnaire there is no clear meaning attributable to a participant not mentioning a factor. This is critical if the factors are then completely ranked.

## IV. QUESTION 2

### What types of control and security risks are similar among the major ERP systems?

	<b>Reported Frequency (%)</b>
All the major systems consider controls.	86.4
The major systems all have the same financial controls.	18.2
The major systems all attempt to mirror the same business processes.	4.5

### What Does the Relative Ranking of “Systems Controls” Mean?

Consider the 18.2 percent that reported “The major systems all have the same financial controls.” What portion of that 18.2 percent was partners or managers? What level of expertise thinks that all systems have the same controls? The data should be partitioned so that levels of expertise and functional area are clarified.

### “All the Major Systems”

How can we infer anything about “all the major systems”? Generally, experts are familiar with one or two systems. Few would be familiar with three or more. As a result, it is not clear how can opinion about pairs of systems can be used to establish evidence about “all” of the major systems. For statements about “all the major systems” we should rely on those who have had experience with “all,” which undoubtedly would be a very small portion of the sample.

### System Characteristics Are Not a Matter of Opinion

Determining any of the three findings listed above does not require the opinion of a panel of experts. Instead, determining if “All the major systems consider controls,” is something that can be directly attacked by the researchers, rather than relying on opinion. Similarly, determining if “The major systems all have the same financial controls” is an issue that should be addressed directly rather than relying on the opinion of a heterogeneous quality group of experts.

### What Did We Learn That Was New?

Further, it is difficult to imagine that any firm would purchase an ERP system that did not have controls. In addition, in a world where software firms have access to other software, we would expect characteristics of software that users want to find its way to all major competitors. As a result, the contribution from this question seems limited.

The surprising response is the notion that “the major systems all attempt to mirror the same business processes.” However, this opinion was expressed by a single individual. Unfortunately, we don't know the level or type of expertise of this participant.

## VI. QUESTION 3

### What types of control and security risks are different among the major ERP systems (SAP, Oracle, PeopleSoft)?

	<b>Reported Frequency (%)</b>
The major systems differ as to access or encryption controls.	95.5
The major systems have different input devices or controls.	68.2
The major systems differ as to interface; some interfaces are more difficult.	27.3
The major systems differ as to conversion; some are more difficult.	9.1
The major systems differ as to process application.	4.5
The major systems differ by module.	4.5

### What Does the Relative Ranking of “Types of Controls and Risks” Mean?

Which of the participants did not think that the major systems did not differ as to access or encryption controls? What level were they? If that one person was a partner or a consultant, then our level of concern as to why only one person did not indicate the issue could be different.

Similarly, what does it mean that 68.2 percent of the participants asserted that “the major systems have different input devices or controls”? Does that mean that the systems do or do not? Unfortunately, that issue and the other five listed in this question should not be based on opinion.

### “The Major Systems Differ”

Few participants have had experience with more than two ERP packages. As a result, it is not clear how we can make an inference about “The Major Systems” when knowledge is likely to be based on two packages. In order to make opinion statements about “The Major Systems,” we should be concerned only with the participants that are familiar with each of the systems. I anticipate that would be a small portion of the sample.

### System Characteristics Are Not a Matter of Opinion

What does it mean to have 95.5 percent assert that “the major systems differ as to access or encryption controls”? The real issue is, “Does it mean that the major systems differ as to access or encryption controls?” Not necessarily, the data is all opinion.

Further, as with Question 2, the conclusions listed here are not those that I would think should be assessed by gathering opinion from a heterogeneous group of experts. Instead, assertions such as “The major systems differ as to access or encryption controls” are testable by the authors, rather than relying on opinion. In addition, relying on opinion leaves us wondering what the numbers really mean and what is their contribution.

### What Did We Learn That Was New?

Consider the case of user interfaces. ERP systems are package software that is developed at different times, in different places, for different purposes in different political settings. Thus, it would be surprising if major packages did not have different user interfaces. Further, if some firm copied exactly some other firm's interface, I am sure that there would be some litigation at stake, providing additional evidence of the likelihood of the existence of different interfaces. Finally, by examining the previous literature, the notion that different systems actually have different interfaces and that those interfaces are easier or harder on some users, has been discussed by a number of researchers, including O'Leary (2000). Similar comments can be specified for each of the other issues listed above.

## VII. QUESTION 4

**Do some ERP subsystems (i.e., payroll, supply-chain management, business intelligence) exhibit greater control and security risks than others? If so, which subsystems exhibit greater risk and why?**

Subsystem	Reported Frequency (%)
Supply-chain	77.3
Payroll	63.6
Financial (financial statements, general ledger)	40.9
Interfaces (bolt-ons)	36.4
Research and development	4.5

### What Does the Relative Ranking of "Subsystems" Mean?

Again, which of our experts align with which subsystem? Which do the accountants feel are the riskiest? Unfortunately, the authors do not disclose this information. Such information is critical to generating any meaning out of this data. Otherwise the results might simply reflect the opinion of a single subgroup.

### Expert Opinion

Unlike Questions 2 and 3, Question 4 is not one where the responses can be tested by directly examining the software. Expert opinion can be used as an approach that can prove insightful to examine certain issues.

However, it is not clear what is gained when the insights of less expert participants are aggregated with more expert participants when generating a relative ranking in the list. What do the "real experts" think are the greatest areas of exposure? We do not know from this listing.

### What Did We Learn That Was New?

One potential use of open-ended HEO is to set what might be expected in an area where little is known. However, there are already clear expectations in terms of which ERP subsystems exhibit greater control and security risks. For example, in a discussion of supply chain integration challenges, Harreld (2001, 46) cites AMR (an IT Research Firm) analyst who notes, "You may have for many years trusted your supplier with only so much information. Now you're opening the kimono a little more. That's a little scary." That same article had a single side bar, "No weak security links."

Assume that we have a set of Big 5 partners and we are interested in their opinion as to which modules exhibit greater control and security risks. What else would we expect? From our knowledge of what the Big 5 do, it would be surprising if there was not a focus on risk associated with payroll and financial assets. Further, in Songini (2001b), an entire article is spent discussing the issues associated with customization aspects, including issues such as "bolt-ons."

There is information available in the literature. Researchers should leverage that information to the extent possible.



### VIII. QUESTION 5

**How does (your firm) test the effectiveness of an ERP system's control and security?**

	<b>Reported Frequency (%)</b>
(The firm) reviews the controls.	95.5
(The firm) conducts an audit of the process.	77.3
(The firm) reviews access.	54.5
(The firm) uses a proprietary tool to assess effectiveness.	13.6
(The firm) audits the output.	9.1

#### **What Does the Relative Ranking of "Approaches" Mean?**

Do all three of the firms represented in the sample review the controls? What does this data tell us? What is the level of the participant who did not indicate that the firm they worked for reviewed controls? For the 4.5 percent not present here, does this indicate that their firm does not review controls?

Do all three of the firms conduct audits of the process? What does this data tell us? What is the level of the individuals who did not indicate that the firm conducted audits?

In actuality, I am sure that each of the firms will do at least four of the five approaches, if the client will pay for it. These findings suggest that it is unclear what is gained by using expert opinion to address this issue.

#### **The Approaches Used by a Firm Are Not an Opinion**

If we are interested in what firms do, then rather than gather opinion, we should specifically determine what the firms do. If we are interested in what percentage of the time they review controls, then we need to find some appropriate measure, e.g., number of jobs that they review controls.

#### **What Did We Learn That Was New?**

What can a firm do to analyze ERP access and controls? They can:

- Examine business process controls
- Examine how the software is configured for access
- Use software to analyze how ERP software is configured
- Audit the system design and implementation process
- Analyze data for anomalies

If, in addition, we had specific information about what firms do, then we could test individual's recollections against what services they think their firm provides. However, I am not sure that is a very intriguing research question.

### IX. QUESTION 6

**Does the risk potential vary by the mandatory vs. discretionary nature of ERP subsystems (e.g., mandatory = payroll, discretionary = business intelligence)? If so, how?**

	<b>Reported Frequency (%)</b>
<b>Yes</b>	
Mandatory	13.6
Discretionary	27.3
The risk is company specific.	40.9
The risk is ERP package specific.	22.7

**How Do the Findings Relate to Question 1?**

Recall that in Question 1, it was indicated that users were a “problem.” Users did not participate enough and were not well-trained. Users are company-specific, yet only 40.9 percent indicated that risk was company-specific. This finding suggests a lack of consistency in the findings.

**How Do the Findings Relate to Question 4?**

Further, the percentages seem surprisingly low when compared to the other questions. For example, only 13.6 percent expressed an indication that the risk potential varied by mandatory subsystems, yet in Question 4, 63.6 percent indicated that payroll was a high-risk module. There seems to be limited question-to-question consistency. Why?

**The Question Is Not Clear**

It may be that this question was not totally clear. The terms “mandatory” and “discretionary” are not well defined here. In order to implement a particular ERP system it is not “mandatory” that the payroll module be implemented. When ERP systems are implemented, most of the modules are discretionary.

An alternative point of view is that the focus of ERP systems is on transaction processing. As a result, the key distinction would be one of transaction processing vs. nontransaction processing. Is the risk in the transactions or in the way information about the transactions is used?

## X. DISCUSSION

This section provides an overview of the detailed analysis given above.

**Heterogeneous Expertise in Participants**

The participants vary substantially in their experience levels, ranging from 1 to 15 years of ERP experience. Roughly 20 percent of the participants are at the Partner/Director level, 60 percent at the Manager level, and 20 percent at the Senior level and below. Given this heterogeneity, how much should the data be aggregated?

If all the data is aggregated, we are opening ourselves up for a Partner indicating one problem, a consultant indicating another problem, and providing equal weight to each. Since over 80 percent of participants are not partners, it seems that even if the partners agreed on a common set of issues, their responses could be overwhelmed by those of nonpartners. Simply aggregating the results eliminates the ability to analyze opinion differences between groups.

Further, HEO provides opinion and perceptions that can be compared within the group and to other groups. As a result, when gathering HEO it is critical to present the data in a manner that also keeps the different groups separate.

Thus, expertise from different levels needs to be stratified so that we can determine the impact of different levels (e.g., partner and manager) or different sources of knowledge (e.g., accounting or computer science) or different organizations (e.g., firm 1 or firm 2). Statistical testing should be used to indicate whether there are any differences across the sample.

**When Should We Not Rely on Opinion?**

In those settings where there is no real judgment involved, it is not constructive to rely on opinion, particularly heterogeneous opinion. Questions 2, 3, and 5 provide information that should not be opinion-based. A lack of reliance on opinion data is one of the hallmarks of systems research. For example, if there is a question of software capability, then the researcher can perform the necessary analysis to determine the capability of the software (e.g., Weber 1986).

**Open-Ended Questions**

Early in the research life cycle we can use “open-ended” questions to establish directions to examine. However, as we move further in the life cycle, open-ended questions are less productive since various other sources elicit directions that need to be established. For Questions 1, 4, and 6 there was already substantial information in the literature that could have sustained questioning further out in the life cycle.

### What Did We Learn That Was Surprising?

Analysis of the findings of the paper in Questions 1–6 provides limited new knowledge. In at least one case, the data may be more surprising for its omissions. For example, the list of problems from Question 1 did not list going over budget or going over development time or business problems as major issues. This does emphasize the importance of cross sample comparisons and analysis of previous research.

### Data

There are some apparent conflicts in the data. For example, the lower bound on work experience is 0, but the lower bound on ERP experience was “1.”

Further, there seems to be confusion over the sample size. There are a number of percentage numbers that keep occurring throughout the entire set of questions. For example, 4.5 appears 5 times, 9.1 appears 3 times, 13.6 appears 3 times, and 18.2 appears 3 times.

Although the authors tell us that the sample size was 30 at least four times in the paper, these percentages lead me to believe that the computations seem to have been done using 22 as the basis. Otherwise the computations should be redone. A summary of the participant equivalences of the paper's percentages at 22 and 30 participants is presented below. Accordingly, the rounding on 30 seems inappropriate.

<u>%</u>	<u>%*30</u>	<u>%*22</u>
0.045	1.35	0.990
0.091	2.73	2.002
0.136	4.08	2.992
0.181	5.43	3.982

### Number of Participants

The number of participants, whether it is 22 or 30 is too small to provide insight into how different levels of experts respond or how different functional areas respond. Further, the sample is too small to perform any statistical analysis. A larger sample size would have yielded more meaningful results.

### Interviews

I would like to have had more in the paper, probably as an appendix regarding the actual comments. I have been in a number of settings like this and some very useful quotes turn up. Unfortunately, an appendix could contain only a subset of the useful comments and would necessarily be edited.

An alternative approach would be to make the text of the interviews available on the Web. This would allow other researchers to investigate what would be an interesting database. In addition, this could foster additional research in the area.

## XI. WHEN AND HOW DO WE USE HETEROGENEOUS EXPERT OPINION AS A BASIS FOR RESEARCH ON ERP SYSTEMS?

This paper has made a number of assertions about when and how to use heterogeneous expertise as a basis for research on ERP systems.

- Do not use heterogeneous expert opinion when the issue is not a matter of opinion. Laying out characteristics of software is not an area where we should use such opinion. Examine the software and see what is there—it is an empirical question.
- Do not use heterogeneous expertise when you will be aggregating and ordering characteristics suggesting their relative importance. Since the participants have different quality expertise it is not clear what it means when a characteristic is mentioned or not.
- Do not use heterogeneous expert opinion to generate lists, unless there is little or no reason to know what to expect. Use the existing literature where feasible.
- Do not infer to “all” when your experts have knowledge of less than “all.”

- Do use heterogeneous expertise when you are interested in testing the differences of opinions (perceptions) between particular groups. If you have stratified information then use it.
- Do use expert opinion (a single level of that HEO) when you are interested in what experts perceive to be a set of issues, early in the research life cycle.
- Get more rather than fewer participants for HEO, particularly when the questions are open-ended.

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