Communications of the Association for Information Systems

Volume 37 Paper

8-2015

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Recommended Citation

Skinner, R., Nelson, R., Chin, W. W., & Land, L. (2015). The Delphi Method Research Strategy in Studies of Information Systems. Communications of the Association for Information Systems, 37, pp-pp. https://doi.org/10.17705/1CAIS.03702

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Research Paper ISSN: 1529-3181

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Abstract:

In this paper, we discuss the nature and use of the Delphi methodology in information systems research. More specifically, we explore how and why it may be used. We discuss criteria for evaluating Delphi research and define characteristics useful for categorizing the studies. We review Delphi application use in IS research over the last 23 years, summarize lessons learned from prior studies, offer suggestions for improvement, and present guidelines for employing this distinctly useful qualitative method in future information systems research studies.

Keywords: Delphi Method, Experts, Panel, Anonymity, Qualitative, Iteration, Feedback, Bias.

The manuscript was received 10/17/2014 and was with the authors 2 months for 2 revisions.

1 Introduction

Even though qualitative research techniques have been used in information systems (IS) studies for many years, disproportionally low numbers of qualitative papers have been published in top-tier IS journals (Galliers & Huang, 2012). Conboy, Fitzgerald, and Mathiassen (2012) identify this dearth of qualitative publications as being a result of inadequate numbers of qualitative courses in universities, inequity with quantitative content in general research method courses, negative bias perceptions against qualitative approaches from editors and reviewers in leading journals, and a dwindling number of qualitative experts that include leaders, champions, supervisors, and reviewers of qualitative material.

However, this perspective may be changing. As Sarker, Xiao and Beaulieu's (2013) informative MISQ guest editorial illustrates, qualitative publication numbers increased from 2001–2012 across four of the seven journals included in the Association for Information System (AIS) Senior Scholars' basket of journals. This growth suggests the increasing viability of qualitative method use in IS research. As a result, qualitative techniques previously neglected by the IS field have gained in relevance, which, in turn, has made strategic qualitative investigations increasingly significant. Consequently, as qualitative research's importance has grown, so has the requirement for clear qualitative method guidelines.

In this paper, we partially address this need by providing a guide to one of these methods—the Delphi—in the IS field. Developed by the Rand Corporation in the 1950's, the Delphi method is a methodical and interactive research procedure for obtaining the opinion of a panel of independent experts concerning a specific subject. Using previous IS papers that employ the Delphi method as examples, we provide recommendations for assessing and applying the Delphi method when undertaking IS research. This approach is necessary due to the majority of IS papers concentrating on reporting the Delphi study result (i.e., using the Delphi technique for IS theory generation rather than for reflection and evaluation of the method itself (Holsapple & Joshi, 2002; Day & Bobeva, 2005).

Note that, when it comes to selecting an appropriate method for a qualitative research study, we do not suggest that Delphi method selection will be suitable in every scenario. As Benbasat, Goldstein, and Mead (1987) highlight, researchers' goals and the nature of their research topic influence what research strategy they select. As a result, certain research conditions are non-conducive to using the Delphi methodology. However, Rowe and Wright (2001) suggest that the Delphi method is effective when statistical method use is unsuitable, several experts are available, the alternative is simply to average the forecasts of several individuals, or the alternative is using a traditional group. We propose that the Delphi method is particularly appropriate for acquiring expert recommendations when addressing an IS research issue. Due to these specialist authorities having extensive knowledge of specific areas of IS interest, using the Delphi method confirms Powell's (2003, p. 376) observation that "the method... is exceptionally useful where the judgments of individuals are needed to address a lack of agreement or incomplete state of knowledge... the Delphi is particularly valued for its ability to structure and organize group communication".

This paper is organized as follows: in Section 2, we review the method's characteristics and appraise how to undertake the technique as part of IS research. In Section 3, we examine previous IS papers' adoption of the Delphi method, review IS Delphi methodology use, and summarize lessons learned. In Section 4, we conclude the paper and note observations about the method and its potential for future use in the IS field.

2 Delphi Research

2.1 Characteristics of the Delphi Method

The Delphi method first came into being in the early 1950s. Subsequently, over the next 60 years, its reputation as an effective approach to technological forecasting grew, waned, and grew again [1]. Notwithstanding these changes in popularity, previous studies have sought to define and characterize the

[1] See Appendix A for an evaluation of the method's historical background.

method. From these reports, we suggest that studies using the Delphi method should possess the following generic characteristics:

- **Use of experts:** Lilja, Laakso, and Palomaki (2011) suggest that an expert fit for a Delphi panel requires the individual to be at the top of their field of technical knowledge, interested in a wide range of knowledge not only in their own field but everything around it, able to see connections between national and international and present and future development, able to see connections between different fields of science, able to disregard traditional viewpoints, able to regard problems from not only known and safe angles but also unconventional ones, and interested in creating something new. Rowe and Wright (2001) suggest using heterogeneous experts. We describe the requirements that experts should have in more detail in Section 2.
- **Panel:** the panel should consist of a group of selected experts with no size limitations. However, because the main task is to include experts who have the greatest knowledge and experience in the field under review, group size often remains fairly small. Delbecq, Van de Ven, and Gustafson (1975) suggest a panel as little as four experts under ideal circumstances. However, under typical circumstances, the panel is usually between 10 and 30 experts (Baldwin-Morgan, 1993; Doke & Swanson, 1995; Keil, Tiwana, & Bush, 2002; Akkermans, Bogerd, Yucesan, & van Wassenhove, 2003; Daniel & White, 2005; Kasi, Keil, Mathiassen, & Pedersen, 2008; De Haes & Van Grembergen, 2009; Baldwin & Trinkle, 2011; Worrell, Di Gangi, & Bush, 2013). Insofar as research studies have not found a consistent relationship between panel size and decision making effectiveness (Brockhoff, 1975; Boje & Murnighan, 1982), it is highly unlikely that another equally expert group will produce radically different results from a panel of 15 experts (Martino, 1985).
- **Anonymity:** this characteristic supports panelist independence by avoiding the official position status of a panelist potentially affecting others' opinion, expression problems, fear of losing face, or fear of attitudes that might be inappropriate to express in public (Lilja et al., 2011). It also removes the potential for mimicking others and provides a safety net for panelists from having to act as competitors. This guarantees more-objective answers and results. We evaluate anonymity's central role in countering judgment bias in more detail in Section 2.
- **Rounds:** the Delphi method is executed in a series of rounds (Von der Gracht, 2012). Insofar as two rounds are considered the minimum (Bradley & Stewart, 2003), between three and six rounds are required to facilitate realistic findings (Linstone & Turoff, 1975; Custer, Scarcella, & Stewart, 1999). Up to 10 rounds have been suggested as necessary for achieving consensus (Lang, 1994). However, Rowe and Wright (2001) suggest that three structured rounds are generally sufficient.
- **Iteration and feedback:** opinions are collected for analysis and information on the answers is fed back to the panelists for comments and/or as a basis for the next round. In using this feedback, the panelists are obliged to justify their choices, with the build of information proceeding round by round so that the previous phase becomes the source for the next.

2.2 Deciding to Use the Delphi Method

Given a particular research subject, researchers must consider whether the Delphi method is the most productive technique for acquiring maximum insight. This consideration obliges researchers to appreciate the method's advantages/strengths versus its limitations/weaknesses. Hung, Altschuld, and Lee (2008) identify papers reviewing these characteristics in detail (e.g., Eggers & Jones, 1998; Franklin & Hart, 2007; Gordon, 1994; Hartman, 1981; Hsu & Sandford, 2007; Lang, 1994; Linstone & Turoff, 1975; Mitchell 1991; Powell 2003; Price, 2005; Williams & Webb, 1994; Yousuf, 2007). Table 1 summarizes their report outlining the method's respective strengths, advantages, weaknesses, and limitations:

Table 1. Comparison of Advantages / Strengths versus Limitations / Weaknesses of the Delphi Method (Hung et al., 2008)

Advantages / strengths	Limitations / weaknesses
Consensus building	Group pressure for consensus—may not be true consensus
Future forecasting	Feedback mechanism may lead to conformity rather than consensus
Bring geographically dispersed panel experts together	No accepted guidelines for determining consensus, sample size, and sampling techniques
Anonymity and confidentiality of responses	Outcomes are perceptual at best
Limited time required for respondents to complete surveys	Requires time/participant commitment
Quiet, thoughtful consideration	Possible problems in developing initial questionnaire to start the process
Avoids direct confrontation of experts with one another (encourages honest opinion, free from group pressure)	May lead to hasty, ill-considered judgments
Structured/organized group communication process	Requires skill in written communication
Decreasing somewhat a tendency to follow the leader	Potential danger of bias—surveys are open to researchers' manipulation
Focused, avoids unnecessary side-tracking for panelists	Selection criteria for panel composition
Ties together the collective wisdom of participants	Time delays between rounds in data collection process
Cost effective and flexible/adaptable	May force a middle-of-the-road consensus
Validity, as the content is driven by panelists	Concerns about the reliability of the technique
Fairly simple to use	Drop-outs, response rates
Beneficial for long-range educational planning and short-term decision making	
Applicable where there is uncertainty or imperfect knowledge, providing data where little exists before	
Effectively used to establish the basis for future studies	
Accommodates a moderately large group	

Note that solely evaluating the method's relative merits and limitations allows the researcher only partially to determine its potential because reviewing the method's merits through an absolute mode of information processing provides limited information regarding its overall appropriateness (Mussweiler & Epstude, 2009). Evaluating a Method also requires one to compare it with contrasting qualitative procedures to provide a more objective technique appraisal. Techniques that may be considered include action research (AR), which "immerses" the researcher in the research approach by simultaneously assisting in the practical problem solving of a problem and enhancing the competencies of organizational actors (Simon, 2000), and action design research (ADR), which is recommended when considering the design of ensemble technology artifacts (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011).

However, one of the most frequently used alternative methods to the Delphi method is the common survey. While the Delphi method is frequently considered a type of survey, albeit a more complex version, there are key differences between the two techniques. Common surveys seek to identify "what is",

whereas the Delphi method attempts to address "what could / should be" (Miller, 2006)[2]. A further key difference between these techniques is the traditional survey's dependence on a representative sample size. This dependency exists because surveys need to enhance the sample population's external validity to the theoretical population of interest. Surveys must also identify statistically significant effects in the sample population. Although the Delphi method's reliance on expert opinion removes these dependencies, generalizing the opinions and estimations of a non-representative group to a larger population may become problematic (Worrell et al., 2013). However, Worrell et al. (2013) further identify the expert panel having insights above and beyond a representative group, with panel results producing potentially fruitful benefits for both research and practice.

When assessing the feasibility of using the Delphi method, researchers should consider the following questions:

- Is the phenomenon of interest able to be evaluated by a panel of experts?
- Are a sufficient (minimum) number of experts available to make up the panel?
- Is anonymous feedback from the panel of experts feasible?
- Are experts able to dedicate sufficient time to assess the phenomenon over multiple iterations of feedback and evaluation?
- In the absence of precise analytical techniques, is gathering subjective judgments moderated through group consensus the only approach possible (Linstone, 1978)?
- Is personal contact not possible due to time and cost constraints or is it not desirable due to concerns about the difficulty of ensuring democratic participation (Linstone, 1978)?

The Delphi method is, therefore, most effective when research method alternatives are not viable or when constraints exist that cannot easily be overcome when attempting to gather impartial data. However, in the absence of a recognized group of experts or where more effective analytical techniques exist, the Delphi method may not be appropriate. Day and Bobeva (2005) suggest that, since Delphi method inquiries are anchored in aggregations of opinion, they are not helpful for investigating an individual's psychosocial conditions[3]. As a result, Delphi method research is not recommended for research where nuances and experiences of human behaviors must be studied in situ. Veltri (1985) further suggests that Delphi method use is unsuitable when:

- The method is applied for a purpose other than achieving expert consensus
- The Delphi process ideals are violated
- Objective data are available
- Experts are unavailable or reluctant to participate, and
- When the facilitator does not have the appropriate knowledge, education, or time to direct the study or interpret outcomes.

2.3 Guidelines for using the Delphi method

Even though researchers may decide that the Delphi method is suitable for their specific research needs, they may still be unsure as how best to proceed. As such, in this section, we provide practical assistance in understanding and implementing the Delphi method for IS research.

Linstone and Turoff (1975) suggest four broad, distinct phases to using the Delphi method:

- Phase 1: characterized by exploring the subject under discussion. Each individual contributes additional information felt to be pertinent.

[2] For a detailed evaluation criteria comparison between the Delphi method and the traditional survey, see Okoli and Pawlowski (2004).

[3] See Appendix A for a more detailed discussion about the Delphi method's defining characteristics.

- Phase 2: reaching an understanding of how the group views the issue (i.e., where the members agree or disagree, what it meant by relative terms such as importance, desirability, feasibility, etc.).
- Phase 3: if there is significant disagreement, then it is explored to identify the underlying reasons for the differences and to evaluate them.
- Phase 4: final evaluation occurs after all previously gathered information has been analyzed and evaluations fed back to panelists.

These broad phases may be broken down into a step process categorized by three main stages: the exploratory stage, the distillation stage, and the utilization stage (see Figure 1).

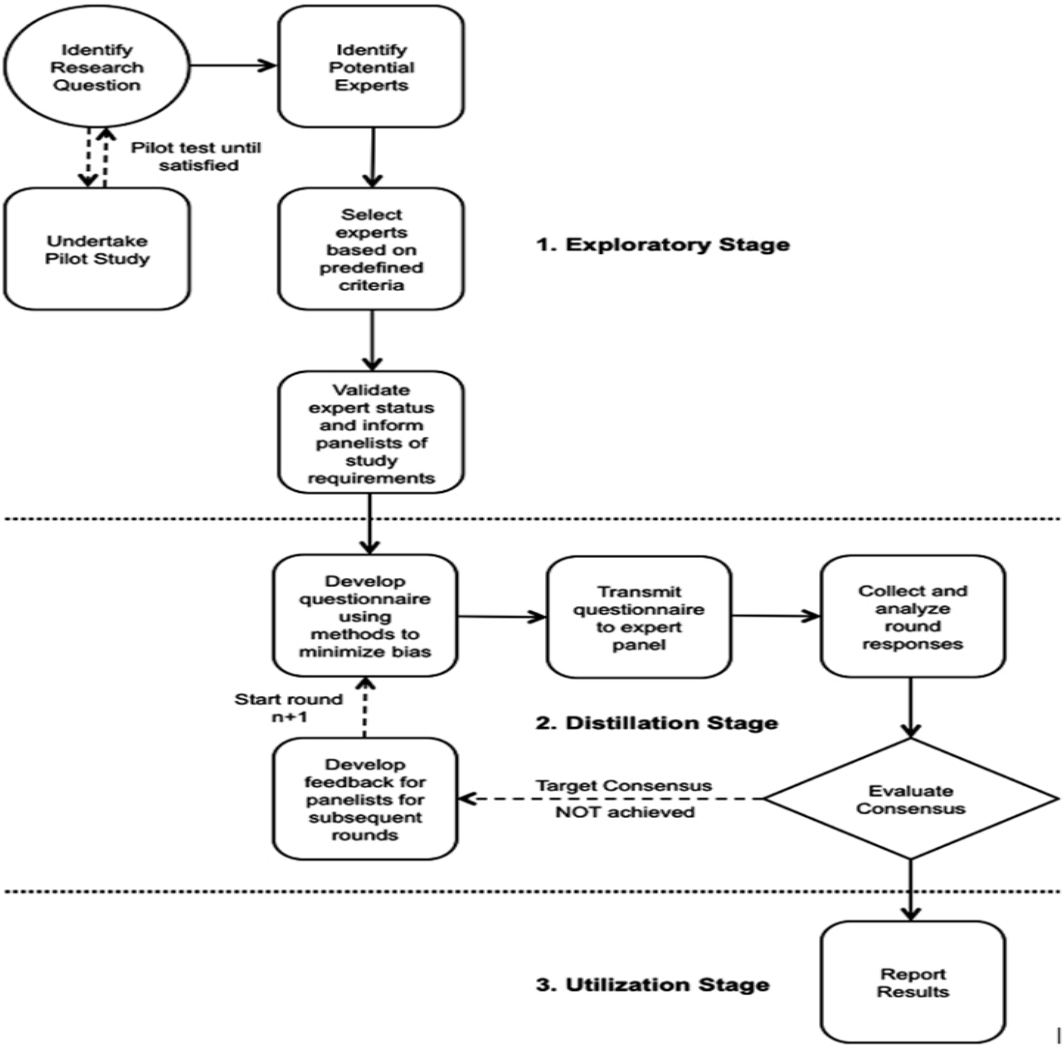

Figure 1. Delphi Process (Adapted from Hallowell & Gambatese, 2010; Day & Bobeva, 2005)

2.4 The Exploratory Stage

The first stage of the Delphi method involves study preparation. It focuses on having a clear understanding of the research question, piloting the study to remove potential methodological obstacles, identifying and validating potential panelists, and selecting the final expert panel.

2.4.1 Identify Research Question

Research must be guided by clear and feasible research questions (Fraenkel & Wallen, 2000). If the questions are not clear, then the research may not result in useful evidence. Furthermore, readers may be

unable to evaluate the investigator's efforts adequately (Fink, 1998). Skulmoski et al. (2007) suggest a continuum representing the degree of focus or openness of the questionnaire questions, which defines how broad or narrow the questions should be. For instance, the preliminary questions may be expansive and open-ended to evaluate a wider research area (Adler & Ziglio, 1996; Delbeq et al., 1975; Linstone & Turoff, 1975), or they may be more defined and structured to direct the expert panelists toward a pre-determined objective. The former approach provides a wider response range compared to the latter, which focuses on the panel's collective intelligence (Skulmoski et al., 2007). The tradeoff with adopting a broad approach is that, with more data collected, subsequent data analysis becomes more time consuming.

2.4.2 Undertake Pilot study

The research team pilots the research questions' effectiveness and proposed approach to ensure that the level of detail is appropriate, the panelists' role is defined, and the instructions are easy to follow (Hallowell & Gambatese, 2010). Undertaking a pilot study also allows one to test for wording difficulties and gives one an opportunity to refine administration tasks (Jairath & Weinstein, 1994). Prescott and Soeken (1989) identify Delphi method pilot tests as providing researchers with an opportunity to refine the research instrument and test data analysis techniques. Piloting the questionnaire also allows for one to discover ambiguities (Gordon, 1994).

2.4.3 Identify Potential Experts, Select Experts, Validate Status, and Inform Panelists of Study Requirements

The research team can use several approaches to identify expert panelists for the study. An expert convenience sample may be selected premised on the researchers' knowledge of experts in the area of interest (e.g., Brancheau & Wetherbe, 1987; Baldwin-Morgan, 1993; McCubbrey, 1999; Schmidt, Lyytinen, Keil, & Chule, 2001; Keil et al., 2002). Conversely, Delbecq et al. (1975) recommend a procedure for expert canvassing for nominal group technique (NGT) research that supersedes any one individuals' knowledge. Using the NGT procedure may be considered in the Delphi process because the differences between the Delphi and the NGT (Appendix 1) only occur once both studies are under way (i.e., Delbecq et al.'s (1975) NGT approach can be used at the outset of using the Delphi method) (Okoli & Pawlowski, 2004). We present an IS-adapted version of Delbecq et al.'s (1975) steps for panel expert identification, selection, and validation below:

- Prepare a knowledge resource nomination worksheet (KRNW). Creating a KRNW provides the research team with a template for categorizing panelists' disciplinary background and/or skills. It includes a literature review of both academic and practitioner journals to support the fields and skills needed for membership (at this stage, focusing on the expertise of members rather than the experts themselves). The research team must also appreciate that IS practitioner experts may not have publications to their name that facilitate their identification as a result of undertaking a literature review. This being the case, using an expert convenience sample may provide a more effective approach to identifying practitioner experts.
- Review and select desired experts. Analyzing the relevant IS literature / individual contacts will provide an initial "wish list" of the most desirable experts to comprise the expert panel.
- Contact experts and request them to nominate further experts in the field. At this stage, there is no formal expert solicitation for joining the Delphi panel. Given that the initially identified experts are best positioned to recommend further experts in the field, the research team can request the original experts to nominate others. This approach provides the research team with the largest overall selection from which to choose the final panelists. This step acquires greater importance when considering subsequent attrition; should those experts who have provisionally agreed to panel membership retrospectively judge the perceived participation overheads as too high, panelist member numbers may drop below the minimum quorum needed. By having the largest selection of experts from which to choose, subsequent withdrawals are contingently addressed. The research team, therefore, reaches out to the initial list of experts and requests their nomination for other experts in the field under research.
- Ranking experts. As a result of the nomination process, it is also conceivable that the overall list of experts will exceed the desired maximum panel number. Should this occur, priority ranking of experts takes place to reduce numbers to the desired panel size. This requires each

research team member to rank all experts independently premised on their perceived "expertness" in the subject under review. Each ranking is subsequently reconciled into an initial list of experts invited for study participation.

- Inviting experts to become members of the Delphi expert panel. Each expert panelist is contacted and requested to join the panel. At this stage, each provisional panelist is provided with the study subject, the method procedures, ethical consent requirements, and expectations of commitment necessary for effective panel membership. Although engaging, concise, and well-written questions may often entice expert participation (Skulmoski et al., 2007), experts are often very busy and unable to participate. However, the research team should be cognizant of the incentives for the experts to participate in the panel. These include being chosen to be a member of a diverse but select group, increasing knowledge as a result of consensus building, and enhancing visibility to the field as a result of panel membership.

2.5 The Distillation Stage

The second broad phase of the study develops the questionnaire, transmits it to the panelists, and collects / analyzes round responses.

2.5.1 Develop Questionnaire Using Methods to Minimize Bias

Having achieved participation agreement from the desired number of panelists, the research team provides a questionnaire that allows the experts to begin investigating the issue. Previously identified as a potential method limitation (Table 1), questionnaire development must be focused on removing the potential for biased feedback because cognitive shortcuts that misrepresent opinion or observation potentially may lead to judgment imprecision (Heath & Tindale, 1994). Contrary to objective techniques where the researcher is most likely to establish bias, should bias occur in a Delphi process, it is more likely to arise as part of the expert judgment process. In this eventuality, eight bias forms are suggested as most likely to impact the studies' result quality negatively (Hallowell & Gambatese, 2010). To facilitate their recognition in the IS Delphi process, we overview these forms here:

- Collective unconscious: Durkheim (1982) suggests that individual beliefs are limitless unless constrained or directed by social forces such as peer pressure or dominance. The collective unconscious theory suggests that a "bandwagon" effect occurs when social forces compel an individual to conform to a majority position. Because bias may occur when a decision maker accedes to popular opinion without giving due consideration towards the merits of any one position, this effect must be considered in a Delphi method study.
- Contrast effect: Bjarnason and Jonsson (2005) propose that, when an individual is evaluating a criterion, the individual may be directly influenced by previous exposure to a similar criterion of substantially higher or lower value. The contrast effect occurs when a subject's perception is enhanced or diminished by the value of the immediately preceding subject. In a Delphi method study, where panelists are required to identify differences among various factors, contrast effect bias may occur when ratings are given against factors that have substantially different values.
- Neglect of probability: this bias considers the scenario where individuals focus on the potential consequences of an outcome without considering the probability that that outcome will occur (e.g., if individuals underestimate the role of probability in a subjective quantification of risk). Accordingly, this bias occurs not as a result of using probability incorrectly, but as a consequence of disregarding the function of probability entirely. Because this bias is relatively common (Martin, 2006), controlling for it is important.
- Von Restorff effect: this bias occurs due to individuals being prone to remembering events associated with more severe outcomes as compared to less severe outcomes. If this occurs, it potentially misrepresents the perception of probability. For example, should a Delphi method study seek to evaluate a risk perception, then this effect may become widespread due to more extreme events being more likely to be recalled when making a subjective judgment. Krimsky and Golding (1992) identify this bias as especially important because subjects are more likely to overestimate probability values when an exceptionally high magnitude is involved. This overestimation may artificially inflate risk scores for events associated with high severity levels.

- Myside bias: Perkins (1989) suggests that myside bias occurs as a result of subjects generating arguments on only one side of an issue. It may also occur when individuals are unwilling to address objective viewpoints that counter a subjective position. Addressing myside bias is critical to the Delphi method's success because individuals may be required to adopt a counter position that challenges a previously held viewpoint. Even though myside bias frequently occurs, Baron (2003) suggests that subjects are easily prompted to contrasting arguments on the issue's other side. He also identifies that the original failure to have considered alternative positions is typically not the result of individuals not knowing the argument on the issue's other side.
- Recency effect: this bias occurs when participants artificially inflate risk ratings as a result of similar incidents recently occurring outside of the study (i.e., recent events are given inappropriate levels of salience in relation to others). While this bias is fairly common and difficult to manage, eliminating those experts who have recently experienced events related to the study may be the most effective control.
- Primacy effect: this effect transpires as a result of unconsciously assigning importance to initial questions or observations to the detriment of following stimuli (i.e., the first stimulus is considered more important than the final observation). Accordingly, the research team must be aware of the subjects' predisposition to conform to the primacy effect at the beginning of the Delphi method.
- Dominance: this bias type usually arises because one group member intimidates others to conform to the member's viewpoint. However, using anonymous feedback in the Delphi method provides an effective control, with equal response weighting providing a further counter to domineering behavior. Anonymity also allows expert subjects to provide their own opinions without undue influence from other panel members.

To reduce the potential of these biases harming the study, research teams using the Delphi method should consider adopting the counter measures presented in Table 2:

Table 2. Example of Full-Width Format for Tables (Source)

Bias	Control / counter measure
Collective unconscious	Require panelists to provide response justification during each round.
Contrast effect	For each round / expert, randomize question order. Report final results as a median.
Neglect of probability	Independently record probability / severity ratings for each risk identified.
Von Restorff effect	Require panelists to justify their responses during each round. Have multiple survey rounds.
Myside bias	Require panelists to justify their responses during each round. Report final results as a median.
Recency effect	Eliminate individuals who have experienced recent similar events, ignore outlying observations, perform multiple rounds, and report final results as a median.
Primacy effect	For each round / expert, randomize question order.
Dominance	Ensure expert anonymity.

Having addressed potential bias concerns, the starting position for the Delphi questionnaire becomes contingent on whether the questionnaire design is exploratory or confirmatory. Hasson, Keeney, and McKenna (2000) suggest that exploratory questions are best implemented by seeking informants' views through initial open-ended questions or via a set of preliminary interviews. This approach is especially appropriate for social science research where situations may be vague, ill defined, or contradictory (Day & Bobeva, 2003). In contrast, the confirmatory approach is typically seen during follow-up studies (Brancheau, Janz, & Wetherbe, 1996; Gottschalk, 2000) where the scenario is generally less ambiguous. This confirmatory variety of Delphi design is customarily undertaken by giving the panel a predefined set of issues to explore (Niederman, Brancheau, & Wetherbe, 1991).

2.5.2 Transmit Questionnaire to Expert Panel

Research teams have different options when deciding how to interact with the expert panel. Cramer (1991) identifies Delphi surveys as originally pen and paper-based and returned to the research team via "snail" mail. While this approach is an option, using email and the Internet affords particular advantages to both researchers and panelist alike. These include the expediency provided by a quick turnaround that helps keep interest alive and participation high. Further, email use provides raw data in a digital format, which eliminates transcription requirements.

2.5.3 Collect and Analyze Round Responses

Analyzing data and reporting results are directly related to question type used in the process. Therefore, appropriate analysis techniques must be used premised on question type and data collected. Schmidt (1997) identifies three distinct phases in data collection, which include issue discovery, issue importance, and issue ranking.

- Issue discovery: the panelists should be initially requested to provide at least six important issues in response to the research question. While researchers may limit the number of items an expert can contribute (Couger, 1988), submitting a minimum number enhances the potential for differing respondents to raise the same issue albeit in different terms. The responses are concatenated into a single list, with those items describing the same issue consolidated in a single term. The panel verifies that these have been mapped correctly and the panelists' ideas fairly represented. Should the research team discover major differences, however, this step may need to be repeated.
- Issue importance: the issues must now be meaningfully ranked. A randomly ordered, consolidated listing from the initial phase is provided to each expert panelist. Each panelist is required to select at least 10 percent of the issues as most important. The research team subsequently eliminates all issues not selected by a respondent majority. Note that, even though this phase aims to reduce the number of options for consideration in the next phase, it may not result in a "reasonable" reduction in the number of list items. In this eventuality, the research team may be challenged to identify alternative actions for trimming the list to a manageable size.
- Issue ranking: the pared list of the top 10 percent of issues is arranged randomly and the expert panelists requested to rank them. Data collection is terminated if broad consensus is achieved as a result of the ranking process. If consensus is not achieved, however, further rounds may be necessary to obtain higher agreement levels from the panel.

Following collection, the data is analyzed. The most appropriate analysis technique depends on the data form collected; it is therefore important to consider that data analysis may involve both qualitative and quantitative data. Hasson et al. (2000) suggest the major statistical techniques used in Delphi method studies are measures of central tendency and level of dispersion (i.e., standard deviation and inter-quartile range) because these most effectively present information regarding the respondents' collective judgment. Eckman (1983) suggests median use based on a Likert-type scale. Mullen (2003) proposes Bayesian weighting to combine responses from using the Delphi method. For ranking data, statistical analysis may be appropriate; Schmidt (1997) summarizes nonparametric statistical techniques to be used in detail, in which he includes Kendall's coefficient of concordance (Kendall's W) to measure consensus level. He suggests that, if Kendall's W is small or large, dissensus/consensus is easily identifiable and, therefore, the decision whether to proceed easy to make. However, if a moderate Kendall W is achieved, Nelms and Porter (1985) identify a trade-off between feasibility (i.e., panel indulgence, researcher resources, and time required) and the potential gain achieved as a result of further rounds. Thus, with moderate consensus levels, the research team must carefully consider the most appropriate next steps. Kiel et al. (2002) advise that a moderate level of consensus is achieved with a Kendall's W of 0.500 and strong consensus at 0.700. Schmidt (1997) interprets differing levels of Kendall's W (see Table 3).

Table 3. Interpretation of Kendall's W (Schmidt, 1997)

W	Interpretation	Confidence ranks
0.1	Very weak agreement	None
0.3	Weak agreement	Low
0.5	Moderate agreement	Fair
z0.7	Strong agreement	High
0.9	Unusually strong agreement	Very high

In contrast, Dietz (1987) suggests that the traditional assumptions made about statistical method use in Delphi method study analysis may be inappropriate. He highlights specific concerns in relation to positive correlation between a panelists' uncertainty across rounds, increases in accuracy as a result of multiple rounds, forecasts weighted by self-reported confidence becoming more accurate versus unweighted forecasts, and the use of robust estimates of statistical location as summaries of expert opinion yielding better forecasts than non-robust measures. As a result of these concerns, researchers must carefully consider which data analysis method is most appropriate[4].

While striving for consensus is often a study's intention, researchers must also consider the scenario whereby agreement is achieved too quickly. This situation can suggest that:

- The subject choice is inappropriate (i.e., the topic is mature, well understood, and not subject to divergent views),
- The research question is presented in such a way as to "lead" the expert panel to only one possible response, and
- The panel is unwilling or unable to contemplate alternative scenarios.

As a result, the research team must judge whether unintended bias has entered the study. In this eventuality, re-structuring the research question to address bias-type may become necessary. An alternative method is to select a panel member to become "devil's advocate". This approach entails a "friendly" expert being selected to provide divergent opinions in such a way that the other panelists are forced to justify, and potentially challenge, their original judgments in greater detail.

2.6 The Utilization Stage

The final stage of the Delphi method reports the result back to the panelists and prepares the findings for publication.

2.6.1 Report Results

It is imperative to provide feedback to the panelists at the study's conclusion. Not only have they given up their time and expertise to facilitate the study, but they will also have an interest in the results. When reporting the Delphi method results, the research team must include the following details (adapted from Schmidt, 1997):

- The total number of issues under consideration in all rounds
- The strength of support for each issue
- The duration of the study
- Approaches to bias management
- Panel selection procedure
- Consensus approach
- The level of confidence in rankings obtained

[4] For a review of Delphi consensus measurement implications, see Von Der Gracht (2012).

- The round-by-round levels of consensus and other measures associated to the research hypothesis
- Sufficient raw data to support any statistical calculations
- The response rate for the initial call, and
- The number of panelists for each round.

The panelists and research team should also agree on whether and how to publicly acknowledge individual panel participation in subsequent publications. Providing details of the panel in following papers may provide the field with heightened confidence in the research findings, particularly if analysis is proportionally qualitative in nature.

In Section 3, we examine how IS researchers have applied the Delphi method.

3 A Review of Information Systems Delphi Method Use

In this section, we discuss the nature and quality of IS papers that have used the Delphi method based on this paper's guidelines for undertaking Delphi research. We present results and lessons learned from IS Delphi research studies: specifically, we analyze three Delphi IS papers in detail to highlight diverse method use premised on significantly different method characteristics.

3.1 Research Themes

To facilitate understanding of the nature and attributes of IS Delphi research, we surveyed IS journals and conference proceedings for the period January 1991 to December 2014. We identified 61 prominent IS research papers that apply the Delphi method (Appendix B). The prevalent theme in these IS Delphi studies is issue identification (i.e., recognizing the key strategic IS issues either at a country level, the organizational executive level, or in specific technological contexts). Insofar as IS issues may occur unexpectedly, the Delphi method is well suited for structuring feedback from experts who are best placed to evaluate these based on previous experience. Selected examples of other IS Delphi study topics include the critical elements of IS infrastructure flexibility (Duncan, 1995), development of a taxonomy of knowledge creation mechanisms (Nambisan, Agarwal, & Tanniru, 1999), scope and requirements of a knowledge management systems (Nevo & Chan, 2007), risk identification (Schmidt et al., 2001; Keil et al., 2002), identification of factors necessary for a successful ITIL implementation (Iden & Langeland, 2010), and top ten remedies for runaway IT projects (Iacovou & Dexter, 2004).

Several papers use the Delphi method in support of a larger study (i.e., Delphi use is only part of investigating greater issue) (e.g., Nambisan et al, 1999; Wynekoop & Walz, 2000; Mulligan, 2002; Lin & Chang, 2008; De Haes & Van Gremberg, 2009). Interestingly, even though Delphi method use is aligned to supporting quantitative and/or qualitative investigations in these mixed-method papers, the majority of the authors do not discuss the mixed-method nature or guidelines of their research when analyzing their data. De Haes and Van Grembergen (2009) are an exception: they adopt a research strategy that "triangulates between multiple different research methods: literature research, pilot case research, Delphi method research, benchmark research, and extreme case research. This triangulation enables us to obtain a richer insight in reality" (De Haes & Van Grembergen, 2009, p. 125). Those authors who fail to actively evaluate their studies' mixed-method nature are limited in their ability to either acquire this level of insight or make further inferences as a result of their investigations:

> *data analysis in mixed methods research should be done rigorously following the standards that are generally acceptable in quantitative and qualitative research ... the quality of inferences from qualitative and quantitative studies contributes greatly to the process of developing high quality meta-inferences. (Venkatesh, Brown, & Bala, 2013, p. 18)*

3.2 Research Objectives

Generally, the papers we reviewed sufficiently articulate their study objectives. Most of the studies are exploratory, with the majority being follow-up research to previously identified challenges. All of the studies conclude with a list of recommendations as a result of the expert feedback. Note that, in four of the studies, the term "Delphi" is not used. However, given the process followed and experts used to generate feedback, we identified these papers as Delphi method studies in all but name.

3.3 Data Collection

As with any investigation, methodological rigor is a cornerstone of "good" research (Skulmoski et al., 2007). Creswell (1994) identifies rigor as critical to quantitative studies, with Sadleowski (1986) doing likewise for qualitative research. Further, Sadleowski (1986) identifies that rigor levels are enhanced as a result of the researcher leaving an audit trail, defined as a clear decision trail of all key theoretical, methodological, and analytical decisions made in the research from beginning to end (Koch, 1994). As part of the data collection process, all of the IS papers we examined adopt the methodology's anonymity characteristic, with several papers discussing its role in their studies. Dexter, Janson, Kiudorf, and Laast-Lass (1993) argue the method prevents dominant individuals from unduly influencing the results that may arise in face-to-face group meetings. Similarly, Akkermans et al. (2003) recognize anonymous panelist feedback that averts groupthink bias. Gonzalez, Gasco and Llopis (2010, p. 245) suggest that:

> *anonymity allows the participants to exchange ideas or preferences with no fear to show a conflicting opinion and without any pressures to reach a consensus ... they do not have to worry about the consequences of their answers and are never under the influence of the most dominant personalities.*

However, because judgment bias is a recognized limitation of the Delphi method (Hung et al., 2008 – Table 1), and the minimization of judgment bias an important aspect of any rigorous study (Hallowell & Gambatese, 2010), by exclusively focusing on anonymity to negate bias, the authors are able to neutralize only the dominance bias type. Similarly, while some authors advise researchers to randomly order questions in the study phase to address other bias concerns (Pervan, 1994; Brancheau et al., 1996; Dekleva & Zupancic, 1996; Pollard & Hayne, 1996; Schmidt et al., 2001), this course of action addresses only primacy and contract effect biases (Table 2). Thus, with no other biases identified or addressed, findings may be subject to judgment biases that limit the papers' validity and reliability.

3.4 Results and Lessons Learned

One of the most prominent examples of the IS field exploiting the Delphi technique has been the Society of Information Management 's (SIM) annual use of the Delphi (and survey) method to identify key issues in IT systems management since 1980. In a recent SIM analysis, Kappelman, Mclean, Luftman, and Johnson (2013) leverage the Delphi method to increase response rates versus previous iterations: "in the interests of increasing the response rate, additional effort was invested in questionnaire design…with questions modified or added based on previous results and suggestions from the Delphi group" (p. 239). Notwithstanding the subsequent survey achieving the highest response rate ever seen in this study (21.7% or 1002/4612 responses), using the Delphi method facilitates the study's objective because it provides experts with opportunity to influence research design and questionnaire content. Survey outcomes subsequently establish that the key issues in IT systems management include the need to align IT with the business, security / privacy, business agility / flexibility, business productivity, and IT time-to-market / speed of IT delivery.

A consequence of the SIM study's consistently achieving desirable outcomes is other IS studies adopting an equivalent methodological framework to accomplish similar outcomes but in different contexts. For instance, the Delphi method is used to identify and rank key issues and concerns facing IS and IT management in country settings that include Taiwan, Australia, and Hong Kong (Pervan, 1994; Wang, 1994; Moores, 1996): "the issue list of this study was based on those checked in previous ones. Specifically, an initial list of 28 issues was adopted from Niederman et al. (1991)" (Wang, 1994, p. 342). Interestingly, as a result of leveraging the SIM study method framework as their methodological template of choice, each of these three studies independently determines that improving IS strategic planning and leveraging IS data as a corporate resource are important issues to be addressed in their respective countries.

The method has also been adopted in studies seeking to identify and rank critical elements and decision variables in *organizational* settings. Doke and Swanson (1995) use the method to investigate the most important decision variables for selecting prototyping in IS development. They justify using the Delphi method premised on the need to achieve consensus on the relative importance of variables while concurrently seeking "to solicit and aggregate information from a group of disjointed individuals " (p. 174). The Delphi method's framework enables this approach because it allows research questions to be communicated asynchronously to a geographically spread panel via a central research team.

Consequently, feedback from managers in 31 firms suggest that the most important variables for selecting prototyping in IS development include clarity of project goals, developer understanding of user requirements, user task comprehension, user contribution, and user availability. Similarly, Duncan (1995) adopts the Delphi method to rank critical issues: she explores the most important items in how practitioners view IS infrastructure flexibility via:

> *a simple Delphi procedure designed to ferret out the issues perceived as critical from the practitioner's point of view… the Delphi study was intended to foster and to focus discussion on those characteristics of IS resources most relevant to infrastructure flexibility (p. 45).*

In recognizing that the Delphi method is used to generate a list of issues as the basis for subsequent interviews, Delphi method use is justified premised on the study's exploratory nature that requires a framework to foster input versus one that provides a rigorous levels of sampling. With the method's anonymous feedback and iterative consensus building advancing this aim, the authors are able to determine the most important items in how practitioners view IS infrastructure flexibility. These include the existence of compatibility rules for communication / networks, data, applications, business management leadership in long-term planning for applications, connectivity of systems across physical locations, and interface standardization. Keil, Lee, and Deng (2013) also adopt the method and identify the most critical IT project manager skills and their relative importance in a rigorous manner (p. 398). As the Delphi technique enables one to identify and rank skills in a single method structure, their use of the method is warranted due to it reducing methodological overheads. Consequently, the authors are able to determine that the top five (of nineteen) most critical skills include leadership, verbal communication, scope management, listening, and project planning.

The Delphi method has also been used in IS framework development. Nambisan et al. (1999) develop a taxonomy of knowledge creation mechanisms using the Delphi method because it is "deemed appropriate when judgmental information is indispensable" (Rowe, Wright, & McColl, 1991, p. 374). In noting that the Delphi method's goal is to use expert opinion to classify mechanisms, the authors conclude that three knowledge types (context free IT knowledge, industry-specific IT knowledge, and firm-specific IT knowledge) interact with two forms of knowledge creation activity (knowledge acquisition and knowledge conversion). Similarly, Holsapple and Joshi (2002) develop a conceptual framework to identify and characterize a generic set of knowledge manipulation (KM) activities. They justify their use of the Delphi method in part due to it providing the authors with independent expert assessment of framework development in the research process. Perhaps more significantly, however, their use of the Delphi method is warranted due to it being part of a framework that serves "as a common language for discourse about knowledge manipulation. For researchers, it suggests issues that deserve investigation and concepts that must be considered in explorations of KM episodes" (p. 477). Ultimately, the study determines a generic set of elemental knowledge manipulation activities that include acquiring, selecting, internalizing, and using knowledge in KM episodes. Sharma, Ng, Dharmawirya, and Lee (2008) likewise use the method to derive a conceptual framework for analyzing knowledge societies. Their innovative work investigates knowledge assets developed in digital communities during economic or leisure activities. They incorporate the Delphi method into an active research approach that provides a "a qualitative and anecdotal validation of our model… we claim face, content and construct validity" (p. 153). While the legitimizing aspect of validation is rarely discussed in IS Delphi method studies, aligning the Delphi method with active research provides novel research opportunities because both methods are abductive in nature. The authors determine that, even though creating a knowledge society encompasses dimensions related to infrastructure, governance, talent and culture, the key elements for sustaining the society are intangible assets that include governance and culture.

Notwithstanding these papers providing an opportunity to appreciate the method's outcome diversity, it is essential that lessons be learned from previous Delphi method use to assist future IS Delphi method studies. Insofar as we have acquired considerable insight into the relative research successes of previous IS Delphi method papers, those studies we deemed most successful "go the extra mile" in providing method operationalization details. While acknowledging that some papers may fail to do so as a result of the editorial review process, authors using the Delphi in a standalone context are obliged nonetheless to operationalize the Delphi technique in as much detail as possible to allow readers to fully appreciate levels of methodological rigor. As an example of a paper succeeding in this approach, Daniel and White (2005) adopt a framework that clearly articulates not only the intention of the study, but also the identification of experts, the nature of the instrument used, the number of rounds, participation and non-response rates,

and analysis of responses. Additionally, authors must help readers compare method operationalization with subsequent data generation / use because it provides an overall "snapshot" of the method's efficacy in achieving the study's research aims. De Haes and Van Grembergen's (2009) exploratory study into IT governance implementations and its impact on business / IT alignment provides an effective example of this relationship as Figure 2 shows.

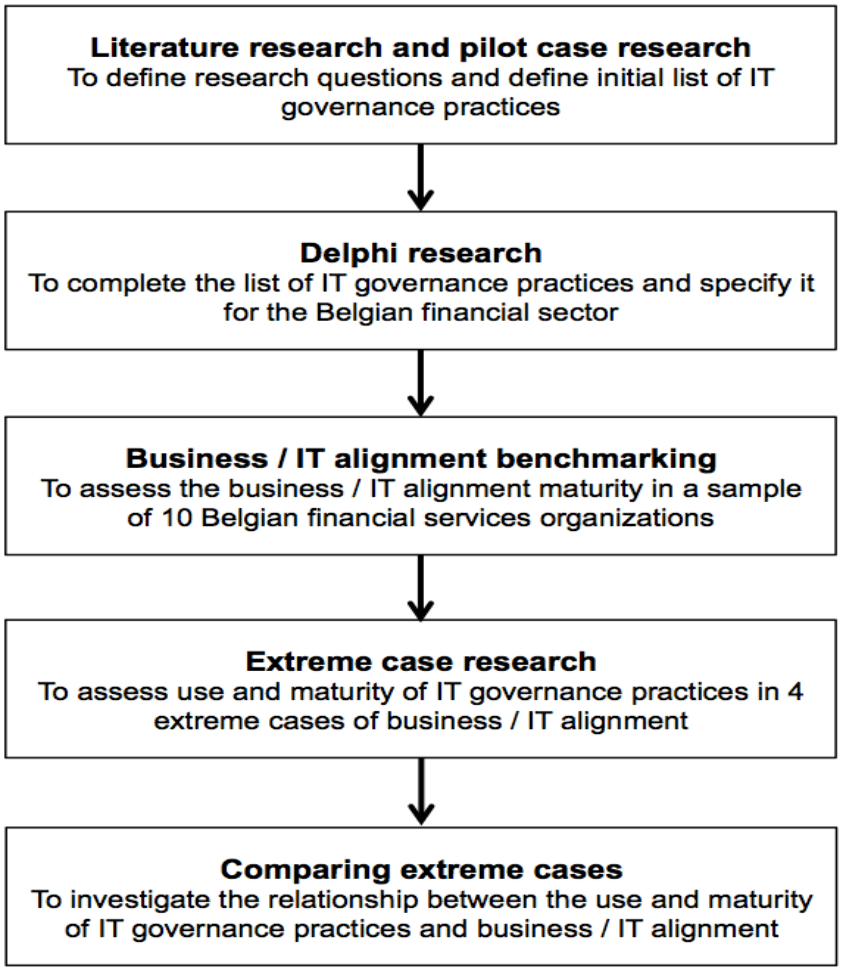

Figure 2. Study Research Process (De Haes & Van Grembergen, 2009)

Note that the majority of the papers we examined incorporate the Delphi method as part of a multi-method approach. In this context, the Delphi method is typically used to leverage subject matter experts as part of a questionnaire derivation process prior to a survey being sent to a sample population. Despite word count restrictions that can potentially limit the same level of method operationalization detail as seen in the standalone context, the complexity of the multi-method approach nevertheless compels authors to show how the Delphi method "sits" in the research study. This requires the author(s) to keep a clear focus on the research aims while ensuring that the reader is able to follow a logical "route" throughout the study. As an example of this aim being achieved, Wynekoop and Walz (2000, p. 189) provide a simple yet informative research design that shows the data collection structure (Figure 3) supported by an explanation of how the methods interact and on what premise (see also Figure 3):

> *The data collection for the planned research will involve two phases: a three-round Delphi study... of IT managers, following by a field study using different participants… the results of the planned Delphi study of IT managers will serve as input for a subsequent field study.*

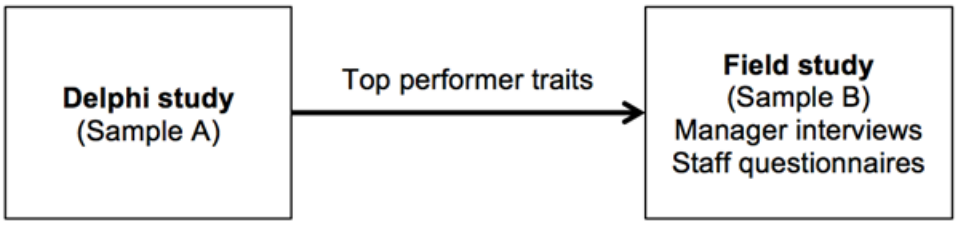

Figure 3: Study Research Design (Wynekoop & Walz, 2000)

In summary, while it is unfortunate that the lack of methodological clarity offered by some IS Delphi method papers obscures potential knowledge-generation opportunities, papers that supply detailed methodological information allow rigor levels to be determined and thereby enhance the field's academic reputation.

3.5 Three Delphi Research Studies

By explicitly contrasting a selection of IS papers, the authors further illuminate Delphi method use and thereby confirm the method's adaptability and diversity. Accordingly, we highlight three papers that adopt the Delphi method but whose characteristics vary significantly. The papers include a review of IT project post mortems (Kasi et al., 2008), a comparison of IT project risks (Liu, Zhang, Keil, & Chen 2010), and a study of inter-organizational IT system linkages (Daniel & White, 2005). The first paper (Kasi et al., 2008) explores an issue identified previously but not investigated; that is, it evaluates how issue choice defines question structure. While the second study (Liu et al, 2010) also investigates an issue, it uses *multiple* expert panels and an extra concluding phase that uses only a portion of the original expert panel. In contrast, the final paper (Daniel & White, 2005) does not seek issue resolution; instead, it forecasts the future direction of system technology use and, therefore, illustrates the impact of prediction versus issue resolution on method design. Table 4 summarizes these contrasting approaches that are supported by differing numbers of rounds and panel and samples sizes.

Table 4. Example of Full-Width Format for Tables (Source)

	Kasi et al. (2008)	**Liu et al. (2010)**	**Daniel & White (2005)**
Study's purpose	Identify barriers of conducting post mortem analysis for IT projects	Identify and compare IT project risk perceptions of IT project managers in Asian culture	The future of inter-organizational system linkages
Study's duration	Not advised	Six months	Not advised
Number of rounds	4	4	3
Number of panels	1	2	1
Sample size per round	23, 23, 23, 23	34/30, 34/30, 34/30, 6/4	17, 15, 11
Delphi design type[5]	e-Delphi	Classical, e-Delphi	Modified, e-Delphi
Questionnaire design	Exploratory	Exploratory	Exploratory
Panel selection procedure	Not advised	Not advised	Convenience sample, snowball.
Consensus approach	Kendall's coefficient of concordance	Kendall's coefficient of concordance	Frequency of Agreement
Bias management	Not advised	Not advised	Anonymity

Evaluating divergent method use across these three studies confirms Delphi method design and use diversity. And despite these differences, it is clear that apparently dissimilar Delphi studies can be broadly comparable. For example, all three studies are exploratory in nature even though their research question structures differ significantly. We can see a further likeness in the abductive approach that all three studies take in arriving at a final list of factors relevant to each structure. In contrast to other qualitative methods (such as field research) where researchers mainly rely on theory or a priori reasoning to arrive at

[5] For a breakdown on different Delphi design types, please see Appendix A.

outcomes deductively (Benbasat et al., 1987), these researchers use the Delphi method in an abductive approach to create theory, with theoretical development derived from the discussions and results of experts with direct experience of a focal topic (Worrell et al., 2013). For a detailed review of these three papers, please see Appendix C.

4 Concluding Comments

In this paper, we explore the nature and use of the Delphi research method, explore how and why it may be applied in IS investigations, survey its use in IS research since 1991, and offer suggestions for improvement. Premised on a guideline for methodology use that is supported by a review of the method's characteristics and the decision-making process, we present 61 IS papers as having applied the Delphi method since the early 1990s. Consequently, we establish the Delphi method being used principally to explore issues and risks as a result of previous research and to forecast future technology application and best practices. This confirms the Delphi method's effectiveness in addressing complex research issues where only partial understanding exists about a phenomenon or where expert participation is required to advance subject knowledge. Furthermore, the contrasting approaches available to using the Delphi method support its position as an adaptable and innovative study procedure. As a result, the technique successfully confronts the field's ongoing concerns that, "despite the gains of qualitative research in the late 20th century, a methodological conservatism has crept upon social science over the last ten years." (Tracy, 2010, p. 837-838)

This paper makes several important contributions:

1. A literature review shows that previous IS method guidelines and prior IS Delphi method application have mostly ignored the importance of pilot testing as part of the method's exploratory stage. We recognize the importance of not ignoring this fundamental task as part of research question generation.
2. The importance of understanding and recognizing differing bias types in using the Delphi method. Identified as a method limitation, appreciating the potential severity of bias on IS Delphi study findings necessitates a greater use of counter-bias techniques to remove opportunity for subsequent validity and reliability concerns.
3. A greater appreciation of the reporting process. Too often are results presented with a focus on outcomes without effective consideration of the interim stages and approaches that have supported their creation. Providing greater detail of study structure and findings can only enhance subsequent reader interpretation.

This paper has two limitations. First, it does not consider the differences in method use that may arise as a result of differing philosophical foundations in the IS field. Insofar as Linstone and Turoff (1975) review the main philosophical perspective underlying the Delphi method's use, a more current philosophical review is required specifically for the IS field. Therefore, future papers should review different approaches to using the IS Delphi premised on contrasting philosophical foundations. Second, this paper focuses on presenting a best-practice approach to Delphi method use premised on the currently accepted structures inherent to the Delphi method. Accordingly, it does not discuss requiring researchers to change any essential aspect of the existing process and thereby accepts the methodology's existing central characteristics. However, changes may be needed to fundamental Delphi method characteristics because of IS's distinct nature that include rapid technological change and innovative data collection methods and analysis. Therefore, future IS Delphi method papers should consider not only the impact of the Delphi method on the IS field, but also how the IS field, in turn, influences the Delphi method.

In summary, when considering using the Delphi method, the IS researcher's fundamental consideration must always be whether using the Delphi method is appropriate. If the problem under review is not articulated clearly or if the initial research question is not structured to facilitate iterative rounds of analysis, then using the Delphi method may fail to provide the research team with the outcomes they desire. Moreover, both expert panelist and research team alike must be mindful of the considerable commitment necessary for successful Delphi research. Consequently, as Worrell et al. (2013) succinctly identify, the challenge becomes to align phenomenon, research, question and method effectively so that the researcher and study make a contribution to the broader literature.

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Appendix A: Delphi Method Historical Background, Definition, and Characteristics

In this section, we examine the method's background, definition, and characteristics and appraise the decision making process when evaluating its potential use.

Historical Background

The Delphi[6] method came into being with "Project Delphi", a name given to a United States Air Force-sponsored Rand Corporation study in the early 1950s. Via a series of intensive questionnaires interspersed with controlled opinion feedback, the study's objective was to obtain the most reliable opinion consensus from an expert group (Dalkey & Helmer, 1963). The study estimated the number of A-bombs required to reduce U.S. munitions output by a prescribed amount from a Soviet strategic planner's point of view (Linstone & Turoff, 1975).

Delphi method use went "mainstream" with a 1964 report ("Report on a Long-Range Forecast", Gordon & Helmer, 1964) to assess the direction of long-range trends on science and technology and their effects on society and the world. Noted contributors to this report include Isaac Asimov, Arthur Clarke, Bertrand de Jouvenal, Ithiel de Sola Pool, Dennis Gabor, Peter Goldmark, Harold Guetzkow and William Pickering (Gordon & Helmer, 1964). Post-publication, there was positive reaction to the method. Over time, however, the report aroused doubts and criticism, primarily because the method was perceived as generating too simplistic results (Bell, 1997). Consequently, Delphi method use was forgotten in the West for a decade. Researchers returned to the method in the early 1980s due in no small part to Linstone and Turoff's (1975) seminal publication *The Delphi Method—Techniques and Applications*. In the meantime, however, Japan assumed the major development and broader application of the Delphi technique. In 1969, the Japanese Science and Technology Agency began the largest ongoing Delphi study ever undertaken into the future of science and technology (Cuhls, Blind, & Grupp, 1998). This study has been run every five years, with the ninth iteration being published in March 2010. The intention of the most recent study is to identify four "grand challenges" defined to focus future efforts in science and technology. These include determining the central players in the scientific and technological fields, how best to achieve sustainable growth through "green" innovation, the most successful model for a health-aging society, and how to secure life (Kuwahara, 2010).

Since the 1980s, the Delphi method has been adopted across a variety of fields, including governmental, medical, environmental, social studies and business and industrial research (Linstone & Turoff, 2002). In these fields, Day and Bobeva (2005) identify the Delphi method as primarily employed for forecasting, planning, issue identification, prioritization, and framework/strategy development (Okoli & Pawlowski, 2004)[7]. The Delphi method use is most frequently seen in the forecasting and planning literature, with a prominent journal in this field—*Technological Forecasting and Social Change*—dedicating a special issue to the technique in 2011.

Definition and Characteristics

As we summarize below, the Delphi method may be defined in multiple ways. For our purposes, the Delphi method's definition has been established through the works of Linstone and Turoff (1975), Rowe, Wright, and McColl (2005), Day and Bobeva (2005), Delbecq, Van de Ven, and Gustafson (1975), and others.

The Delphi method may be characterized as a technique for structuring a group communication process. This characterization suggests the technique's effectiveness in allowing a group of individuals, as a whole, to deal with a complex problem (Linstone & Turoff, 1975). Rowe et al. (2005) identify the Delphi technique

[6] The name "Delphi" derives from the Oracle of Delphi in ancient Greece. For a review of the method's classical origins, see Marchais-Roubelat and Roubelat (2011).

[7] For a discussion of Delphi use in the Social Sciences, see Landeta (2006).

as a forecasting tool developed to allow the benefits of canvassing multiple judges without the often-corresponding deficits arising from social processes and group interactions. It is a structured group process; specifically, Delphi is a structured group communication method for soliciting expert opinion about complex problems or novel ideas through using a series of questionnaires and controlled feedback (Day & Bobeva, 2005). Hsu and Sandford (2007) identify the Delphi technique as being designed as a group communication process that aims to conduct detailed examinations of a specific issue to set goals, investigate policy, or predict the occurrence of future events (Ulschak, 1983; Turoff & Hiltz, 1996; Ludwig, 1997). Scholl, König, Meyer, and Heisig (2004) identify the Delphi process as being particularly well suited for exploring theory building on complex, interdisciplinary issues that may involve new or future trends. Delbecq et al. (1975) suggest that the Delphi method may be used to:

- Determine or develop a range of possible program alternatives
- Explore or expose underlying assumptions or information leading to different judgments
- Seek out information that may generate a consensus on the part of the respondent group
- Correlate informed judgments on a topic spanning a wide range of fields, and
- Educate the respondent group as to the diverse and interrelated aspects of the topic.
- Note that, while the impetus behind the Delphi method is often to seek expert consensus (Fomin, Pedersen, & de Vries, 2008), consensus is less important than crystalizing reasons for *dissensus* (Gordon, 1994).

Note that, while the impetus behind the Delphi method is often to seek expert consensus (Fomin, Pedersen, & de Vries, 2008), consensus is less important than crystalizing reasons for *dissensus* (Gordon, 1994).

Deciding when to use the Delphi method is, therefore, not straightforward, even when considering other qualitative techniques that exclusively use expert feedback. Hallowell and Gambatese (2010) identify alternatives to the Delphi method for extracting expert opinion, including the use of staticized groups, interacting groups, and the NGT. The staticized group method is identical to the Delphi method except that he former excludes feedback or iteration; that is, it is the *aggregate* response of experts from initial questioning, with all interaction between group members removed. Interacting groups, also known as focus groups, require experts to congregate in a single physical or virtual location to communicate and interact with each other in real time. This approach removes anonymity, which, in turn, enhances bias potential as a result of one individual dominating others. It may also create additional costs associated with the financial and logistical challenges of gathering experts in one location. The NGT is a group process for eliciting opinions and aggregating judgments to increase rationality and creativity when faced with an unstructured problem situation (Deip, Thesen, Motiwalla, & Seshardi, 1977). It uses the same process as the Delphi except that feedback is given via face-to-face meetings and discussions between rounds. Even though this approach is effective at facilitating data collection, it may result in biased results and conformity due to the removal of panelist anonymity.

Delphi Design Types, Phases and Steps

Once researchers have considered a method's strengths versus weaknesses, its merits versus its limitations, its efficacy versus other qualitative research techniques, and its suitability versus other methods that adopt expert feedback, they need to evaluate the potential differing types of Delphi designs to select that which is most appropriate. Keeney (2009) identifies 10 distinct Delphi designs that differentiate by their research aims. Depending on the research team's intention, a design type choice is made. These design types include classical, modified, decision, policy, real time, e-Delphi, technological, online, argument and disaggregative (see Table A-1).

Table A-1. Delphi Design Types (Hasson & Keeney, 2011)

Design type	Aim	Target panelists	Administration	# of rounds	Round 1 design
Classical	To elicit opinion and gain consensus.	Experts selected based on aims of research.	Traditionally postal.	Three or more rounds.	Open qualitative first round to allow panelists to record responses.
Modified	Aim varies according to project design—from predicting future events to achieving consensus	Experts selected based on aims of research.	Varies, postal, online, etc.	May employ fewer than 3 rounds.	Panelists provided with pre-selected items from various sources in which they are asked to consider their responses
Decision	To structure decision making and create the future in reality rather than predicting it.	Decision makers selected according to hierarchical position and level of expertise. Policy makers selected to obtain divergent opinions.	Varies.	Varies.	Can adopt similar process to classical Delphi
Policy	To generate opposing views on policy and potential resolutions.	Policy makers selected to obtain divergent opinions.	Can adopt a number of formats including bringing participants together in a group meeting.	Varies.	Can adopt similar process to classical Delphi
Real time / consensus Conference	To elicit an opinion and gain consensus.	Experts selected based on aims of research.	Use of computer technology that panelists use in the same room to achieve consensus on real time than post.	Varies.	Can adopt similar process to classical Delphi
e-Delphi	Aim can vary depending on the nature of the research.	Expert selection can vary depending on the aim of the research.	Administration of Delphi via email or online Web survey.	Varies.	Can adopt similar process to classical Delphi
Technological	Aim varies according to project design from predicting future events to achieving consensus.	Experts selected based on aims of research.	Use of hand-held keypads allowing responses to be recorded and instant feedback provided.	Varies.	Can adopt similar process to classical Delphi
Online	Aim varies according to project design from predicting future events to achieving consensus.	Experts selected based on aims of research.	Implementation of the technique on any online instrument such as a chat room or forum.	Varies.	Can adopt similar process to classical Delphi
Argument	To develop relevant arguments and expose underlying reasons for different opinions on a specific single issue.	Panelists should represent the research issue from different perspectives.	Varies.	Varies.	Can adopt similar process to modified Delphi
Disaggregative policy	To construct future scenarios in which panelists are asked about their probable and preferable future.	Expert selection can vary depending on the aim of the research.	Varies.	Varies.	Adopt modified format using cluster analysis
Design type	Aim	Target panelists	Administration	# of rounds	Round 1 design

Appendix B: Prominent Is Papers That Have Applied the Delphi Method (1991–2014)

From our surveying IS research journals and conference proceedings for the period January 1991 to December 2014, we present 61 prominent IS research papers that apply the Delphi method (Table B-1). Papers highlighted in bold are published in the AIS Senior Scholars' basket of journals.

Table B-1. Application of the Delphi Method in IS research (1991-2014)

Author(s) and year	Journal	Delphi focus	Rounds	Sample size
Madu, Kuei, & Madu (1991)	Long Range Forecasting	Setting priorities for the IT industry in Taiwan	3	
	4			
Niederman et al. (1991)	MIS Quarterly			
	Survey senior IS executives to determine the most critical IS issues for the 1990s	3	114, 126, 104	
de Haan & Peters (1993)	Information & Management	Review of a Dutch study into advanced manufacturing technology techniques	3	23
Dexter et al. (1993)	Journal of Strategic Information Systems	Key information technology issues in Estonia	3	10, 24, 24
Pervan (1994)	Proceedings of the 4th Australian Conference on IS	Studies of key issues in Australian IS management	3	88, 97, 88
Wang (1994)	Information & Management	IS management issues in China in the 1990's	3	6, 3, 3
Doke & Swanson (1995)				
	Information & Management	Decision variables for selecting prototyping in IS development	3	31,29, 27
Duncan (1995)	Journal of Management Information Systems	Identify and rank the critical elements of IS infrastructure flexibility	2	21
Brancheau et al. (1996)	MIS Quarterly	Survey SIM members to determine the most critical IS issues in the next 3-5 years	3	78, 87, 76
Dekleva & Zupancic (1996)	Information & Management	IS management issues in Slovenia	3	105, 163, 129,
Moores (1996)	Information & Management	Key issues in IS management in HK	2	108
Pollard & Hayne (1996)	Proceedings of the 29th Hawaii Conference on System Sciences	IS issues facing Canadian businesses	2	176, 158
McCubbrey (1999)	Communications of the Association for Information Systems	Predicting the effects of electronic commerce technology on air travel		
	3	17		
Nambisan et al. (1999)	MIS Quarterly	Develop a taxonomy of knowledge creation mechanisms	3	11

Table B-1. Application of the Delphi Method in IS research (1991-2014)

Chang, Gable, Smythe, & Timbrell (2000)	Proceedings of the 21st International Conference on Information Systems	A Delphi examination of public sector ERP implementation issues	2	61
Hayne & Pollard (2000)	Information & Management			
	Identify the critical issues in IS in the coming 5 years for Canadian IS executives and non-managers	3	157	
Martinez (2000)	Futures	Social trends of the information and communication technologies in Spain	Not advised	32
Scott (2000)	Journal of Product Innovation Management	Rank technology management issues in new product development products	3	20
Wynekoop & Walz (2000)	Information Technology & People	Rank the most important characteristics of high performing IT personnel	3	9
Ausadamongkol & Loveridge (2001)	Foresight	Technology foresight in Thailand	2	56
Bacon & Fitzgerald (2001)	DataBase for advances in Information Systems	Develop a framework of the main areas of the IS field	Not advised	52
Lai (2001)	Information & Management	International IS management issues—a perspective of affiliates	2	46
Schmidt et al. (2001)	Journal of Management Information Systems	Identify and rank software development project risks: an international comparative study	3	13, 13, 13
11,11, 9,				
21,21,9				
Holsapple & Joshi (2002)	Information & Management	Develop a descriptive framework of elemental knowledge manipulation activities	2	31, 17,
Keil et al. (2002)	Information Systems Journal	Rank software development project risks	3	15,15,10
Lai & Chung (2002)	Information & Management	Identify a prioritized list of international data communication activities vital to organizations in managing information exchanges	2	Not advised
Mulligan (2002)	Information & Management	Specificity of a capability-based IT classification framework	3	31
Akkermans et al. (2003)	European Journal of Operational Research	Examine the future effects of ERP systems on SCM	8	23
Bradley & Steward (2003)	Marketing Intelligence & Planning	A Delphi study of Internet banking		
	2	50, 33		
Dexter et al. (2003)	Journal of Strategic Information Systems	Key information technology issues in Estonia	3	10, 24, 24
Nevo, Benbasat, & Wand (2003)	Proceedings of the 2003 International Conference on Information Systems	Exploring meta-knowledge for knowledge management systems	4	28

Table B-1. Application of the Delphi Method in IS research (1991-2014)

Erickson & Siau (2004)	Proceedings of the 2004 International Conference on Information Systems	Analysis of the theoretical and practical complexity of the unified modeling language	3	29
Brungs & Jamieson (2005)	Information Systems Management	Identify and rank computer forensics legal issues	3	11
Daniel & White (2005)	European Journal of Information Systems	The future of inter-organizational system linkages	3	11
Nevo & Chan (2007)	Information & Management	Scope and requirements of knowledge management systems	3	21
Worrell & Bush (2007)	Proceedings of the 2007 Americas Conference on Information Systems	Perceptions of information technology risk	2	17/15/12, 16/14/11
Fomin et al. (2008)	Communications of the Association for Information Systems	Identify issues related to government policy on open standards of public ICT infrastructure	3	13
Kasi et al. (2008)	European Journal of Information Systems	Identify barriers of conducting post mortem analysis for IT projects	4	23
King & Torkzadeh (2008)	MIS Quarterly	Research status and issues in IS offshoring	3	101
Lin & Chang (2008)	International Journal of Technology Management	Relational model of medical knowledge sharing and decision making	2	20
Sharma et al. (2008)	Journal of Knowledge Management	Deriving a conceptual framework for analyzing knowledge societies	3	13
De Haes & Van Grembergen (2009)	Information Systems Management	Examine how organizations implement IT governance and to explore its relationship versus business / IT alignment	3	22
Nakatsu & Iacovou (2009)	Information & Management	Risk factors involved in software outsourcing	3	32
O'Neill, Murray, & Kieran (2009)	Proceedings of the 2009 European Conference on Information Systems	Collaborative learning in distance education	2	18
Garcia-Crespo, Colomo-Palacios, Soto-Acosta, & Ruano-Mayoral (2010)	Information Systems Management	Hard decision making in managing global software development teams	2	25
Gonzalez et al. (2010)	Business Process Management Journal	IS outsourcing in Spain	2	329, 18
Iden & Langeland (2010)	Information Systems Management	Identify the factors necessary for a successful ITIL implementation		
	3	12		
Liu et al. (2010)	Information Systems Journal	Identify and compare IT project risk perceptions of IT project managers in Asian culture	3	30,34
Müller, Linders, & Pires (2010)	Information Systems Management	Business Intelligence and service-oriented architecture	3	16, 13, 11

Table B-1. Application of the Delphi Method in IS research (1991-2014)

Philip, Schwabe, & Wende (2010)	Proceedings of the 2010 Americas Conference on Information Systems	Identifying early warning signs of failures in offshore development projects	3	21

Appendix C: Papers Reviewed For Contrast and Comparison of Delphi Method Use

The Post Mortem Paradox: A Delphi Study of IT Specialist Perceptions **(Kasi et al., 2008):** Kasi et al. examine why post mortem evaluations (PMEs), advocated as a means of improving development practices by learning from IT project failures, are routinely not undertaken by organizations. Kasi et al. explore the reasons for this apparent contradiction insofar as managers are provided with opportunity to learn from previous failures but routinely do not do so. The authors use findings from a Delphi method study of 23 experienced Swedish practitioners working in IT organizations who were tasked with considering the most important barriers to conducting a PME. Integrating findings from organizational learning theory, the authors suggest that most organizations face a post mortem paradox that stems from critical tensions between development practices and learning contexts. In these cases, adopting PMEs is likely to reinforce organizational learning dysfunctions rather than improve current development practices.

Kasi et al.'s (2008) decision to use a Delphi study is premised on research questions that focus on identifying the most important barriers to conducting IT project PMEs, discovering why PMEs are seldom practiced to learn from failures in IT organizations, and investigating under which conditions PMEs are successfully adopted in IT organizations. The authors justify these questions through their work building on previous studies that identified the barriers' existence (Pederson, 2004, 2005) but where no systematic attempts were subsequently made to investigate these further. They validate Delphi use via the nature of the research questions and the exploratory character of the study requiring expertise in IT project post-mortems. Thus, the authors take advantage of prior research that suggests that a problem that has not been systematically analyzed exists and that an opportunity occurs for further investigation through access to practitioners with issue experience. With the first phase incorporating an initial list of factors requiring expert validation, Kasi et al. add to the fields' knowledge about IT project success by providing a ranked listing of the top 19 barriers identified by the expert practitioners. A strength of the paper can be seen in the detail provided about the panelist demographics: these include work experience, organization size, numbers of projects managed, educational qualifications, experience of project management improvement, and experience of performing project post-mortem evaluations. However, a weakness is its lack of detail about how the research team addresses the potential for bias entering the study. For instance, the reader is forced to assume that the barriers are presented to the panel in such a way as to minimize the Von Restorff, recency, or primacy effects. A further concern is panel selection: even though we are provided with detailed panelist demographics, we are not advised the panelist selection procedure (i.e., "We formed our panel of experts by recruiting project managers with experience conducting PMEs") (Kasi et al., 2008, p. 68). This lack of transparency in the selection process potentially undermines the independence of the study's findings. Finally, compared to choosing panelists from IT departments in non-IT organizations, using panelists exclusively from IT organizations may prejudice the perspective of the role of IT post mortems: "our panel was comprised of 23 experienced practitioners working in IT organizations" (Kasi et al., 2008, p. 68). By being exposed to a wider selection of industries than only the IT industry, a richer set of perspectives may be obtained.

Comparing Senior Executive and Project Manager Perceptions of IT Project Risk: A Chinese Delphi Study **(Liu et al., 2010):** in a study of Chinese executive and project manager risk perceptions, Liu et al. investigate the low success rate for IT projects. They compare executive and project manager risk perceptions to identify:

- The top-ranked risk factors associated with IT project failure
- The areas of agreement and disagreement between the differing groups' perceptions of IT project risk, and
- Where there is agreement, approaches for dealing with the risk factors.

The paper compares feedback from 34 project managers (PM) and 30 senior executives (SE) in two panels. The findings suggest that project managers tend to concentrate on lower-level risks and emphasize risks associated with requirements and user involvement, whereas senior executives are inclined to focus on higher-level risks including those involved with politics, organizational structure, process, and culture. The authors found that both groups perceived seven areas of risk to be important, including a lack of top management commitment to a project, project implementation having a major effect on business processes and organizational structure, incorrect system requirements, a lack of adequate user participation, and effective development and project management methodologies. Ten panelists selected from the original 64 experts provide approaches to managing each of the seven risk factors. From a methodology perspective, this study differentiates from Kasi et al.'s (2010) paper by adopting a multi-panel approach and by requesting the panel to brainstorm to provide the initial list of factors. The multi-panel approach is justified by the research questions' comparing executive and project manager perspectives and by the research being exploratory in nature (i.e., the study seeks to find the overall agreement level between these groups): "Surprisingly, however, Senior Executive['s] perceptions towards IT project risk have not been examined. This study seeks to remedy this gap in our understanding by examining the SE perspective on IT project risk and comparing it to the Project Manager perspective" (Liu et al., 2010, p. 324). The authors adopt the brainstorming approach due to their objective to identify risk-related factors not confirmed previously: "In phase 1, a brainstorming round was conducted to produce as many items as possible from both panels." (p. 325). This paper further differentiates from Kasi et al.'s by employing a fourth phase to the study, whereby the authors identify 10 panelists to recommend approaches for addressing those risk factors existing in both ranked lists.

The authors provide detailed descriptions of the methodology's four phases used to obtain the ranked list of risk factors for each panel (Figure 1, p. 326). They also note the duration (six months) needed to acquire expert feedback over these phases. Including these details provides the reader with a greater appreciation of the impact to both expert and research team as a result of undertaking the study, which, in turn, enhances study outcome evaluation. A further strength is in the authors' conducting a final integrated round to solicit feedback from both the panels on the comparison findings across the panels. This approach allows the authors to allay potential concerns about how the research team's itself observes and interprets the experts' findings. Similar to Kasi et al.'s paper, however, the authors do not provide details about how they mitigate the potential for bias impacting the respondents' feedback, which, in turn, requires the reader to make conjectures about how, if at all, judgment bias was addressed. The authors also fail to provide information about panel selection, either for the study as a whole or for the final recommendation phase, which again requires the reader to infer expert choice impartiality.

***The Future of Inter-Organisational System Linkages: Findings of An International Delphi Study* (Daniel & White, 2005):** Daniel and White's study of inter-organizational IT system linkages is perhaps the "strongest" of the three papers from a methodology perspective. Its investigation is premised on the need for businesses to perform more effectively in turbulent and volatile markets by forming IS connections with business partners. The authors identify IS and IT developments that facilitate this requirement, including electronic hubs, Web services, adoption of enterprise resource planning (ERP) systems, and enterprise portals. They explore the future role and use of these systems over a ten year period, with the study using 35 participants representing differing roles in both practitioner and academic contexts. This paper suggests that system and technology use reduce the cost and complexity normally present when forming organizational links, leading to opportunity for more dynamic levels of trading and collaboration. The authors further suggest that ERP systems are potentially reaching a structural limit in their capability to perform this inter-organizational business function and that other technologies will be required to integrate multiple inter-organizational operations. These technologies include electronic hubs, web services and enterprise portals. This paper's approach, therefore, diverges from the previous papers by researching the future direction of factors identified prior to study launch. Thus, the study's premise is to not solely obtain consensus through factor reduction but also predict future component use. This variation potentially creates differing, and more challenging, response expectations compared to the relatively simple considerations necessary for a study that seeks solely to reduce factor numbers.

An initial strength of the paper is in their describing the method for expert selection—"peer review" (p. 193)—with participants approached due to their previous participation in complementary research programs. Further, the authors explain how they requested these panelists to nominate other individuals considered to have the expertise necessary for study participation; that is, they adopted a "snowball" approach. This explanation addresses concerns about panel selection criteria, which we identify as a

generic Delphi method limitation. Further strengths include a section on technique operationalization that articulates panel-research team interaction, question design, and response analysis. Similarly to the previous papers, however, the authors fail to address possible judgment bias concerns outside of anonymity use. Furthermore, the authors do not provide details on pilot testing, nor do they provide round-by-round consensus levels. These omissions aside, however, the authors effectively implement other elements of Schmidt's (1997) reporting recommendations, including the strength of support for each issue (e.g., Table 3, p.194), the response rate for the initial call (p .194), and panelist numbers for each round (p. 194). Table 4 summarizes these three papers.

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