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Multilevel Research in Information Systems: Concepts, Strategies, Problems, and Pitfalls

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Abstract

Information systems (IS) researchers often explore complex phenomena that result from the interplay between technologies and human actors; as such, IS research frequently involves constructs found at multiple levels of analysis, although rarely recognized as such. In fact, our targeted review of the IS literature found minimal explicit consideration of the issues posed by multilevel research although a number of studies implicitly conducted research at multiple levels. In this paper, we discuss the issues that result from not explicitly recognizing the multilevel nature of one's work and offer guidance on how to identify and explicitly conduct multilevel IS research. Recognizing the relevance of multilevel research for the IS domain, we discuss a systematic approach to conduct quantitative multilevel IS research that is grounded in an overarching framework that focuses equally on testing variables and entities. We also highlight the unique role of IS in developing multilevel opportunities for researchers. Finally, we identify a number of gaps within the IS literature in which specific multilevel research questions may be articulated. Such explicit consideration of multilevel issues in future IS research will not only improve IS research but contribute to the larger discourse on multilevel research.

Keywords: *Methodology, Multilevel Research, IS Research, Entities, Levels of Analysis, Multilevel Fallacies.*

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1. Introduction

Multilevel research is important in information systems (IS) because of the nature of the phenomena studied in the field; IS research explores the interplay between technologies and human actors (Aubert, Barki, Patry, & Roy, 2008) and studies phenomena where various entities interact with and affect each other (Barki, Titah, & Boffo, 2007). These interactions between entities and the interplay between technologies and people can result in the emergence of higher-level collectives, which should be considered from a multilevel lens. Organizational behavior researchers in the 1980s and 1990s carried out programmatic research in this area, which led to the emergence of a paradigm for this kind of work, broadly labeled multilevel research. These researchers have warned of potential biases of misspecification and aggregation when different units of measurement and/or analysis exist (e.g., Dansereau & Dumas, 1977; James, 1982; Rousseau, 1985; Yammarino & Dubinsky, 1992). Although other fields (sociology, social psychology, education, etc.) have also examined multilevel research issues, we apply the lessons from the management field to the IS research domain given our common business school context.

The areas of research that organizational behavior researchers have identified as multilevel (that is, neither exclusively micro-nor macro-level phenomena, but incorporating two levels or more include: leadership (Dansereau et al., 1995; Gooty & Yammarino, forthcoming; Markham, 2012; Markham, Yammarino, Murry, & Palanski, 2010; Yammarino, Dionne, Schriesheim, & Dansereau, 2008), learning and decision making (Jelinek, 2003; Markham, Groesbeck, & Swan, 2006; Reeves-Ellington, 2007; Sessa & London, 2006; Wei, Zheng, & Zhang, 2011), absenteeism (Consiglio, Borgogni, Alessandri, & Schaufeli, 2013; Hausknecht, Hiller, & Vance, 2008; Markham, 1985; Markham & McKee, 1991, 1995; Yammarino & Markham, 1992), productivity and effectiveness (Consiglio et al., 2013; Di Milia & Birdi, 2010; Koy & Yeo, 2008; Peterson, Arregle, & Martin, 2012; van Veldhoven, de Jonge, Broersen, Kompier, & Meijman, 2002; Wimbush, Shepard, & Markham, 1997; Yammarino et al., 2008), and the use of technological systems (Gobeli, Koenig, & Bechinger, 1998; Sushandoyo & Magnusson, 2012). As apparent from this abbreviated list, IS concepts such as virtual teams, communities of practice, telecommuting, software development, and so forth are potentially multilevel phenomena in which the research question "Which organizational entities are most potent in explaining the phenomenon of interest?" is just as critical as the research question "Which variables are most closely related to each other?"

Multilevel research, like other types of research in IS, can be conducted from a variety of epistemological and research paradigms. Though we focus on clarifying how multilevel research can be best conducted from a quantitative positivist perspective, we also discuss the value of multilevel research from a variety of paradigms. For example, from a constructivist point of view, a study of the effects of IS implementation on individuals and groups within an organization can be conducted using a longitudinal, qualitative, and/or interpretivist research approach. This type of approach would provide valuable insights into the inter-relationships of various constructs at different levels of analysis. In fact, interpretivist research has often used multilevel approaches independently without drawing from positivist scholarship (as we show in our review of multilevel research in IS).

Our targeted review of the IS literature in *Information Systems Research* and *MIS Quarterly* yielded few papers with explicit reference to the multilevel nature of their phenomenon of interest. Our examination of 526 papers from 2002 to 2010 revealed that less than 10 percent used either multilevel theorizing or a multilevel research design. This may be the result of the difficulties in conducting such studies or developing such frameworks. Alternatively, IS researchers may not be sensitive to the multilevel nature of the IS phenomenon under study and thus overlook the opportunity to explicitly address questions related to entities of relevance in both their theorizing and research design. Further, IS researchers generally have failed to recognize and investigate any multilevel role of information technology (IT). Such shortcomings restrict the robustness of research designs, validity of findings, and opportunities to provide novel research contributions.

Fields other than IS appear to consider multilevel concepts more frequently. Take the domain of management, for example, where Hitt, Beamish, Jackson, Mathieu (2007) note that approximately 25 percent of the papers published in the *Academy of Management Journal* between August 2006 and July 2007 used some form of multilevel perspective, while 50 percent published in the *Academy of Management Review* during that time examined multilevel phenomena[1]. Hitt et al. (2007) advocate the use of multilevel methods as powerful tools for contextualizing research theories.

In this paper, we investigate the current state of multilevel studies in the IS literature, discuss the unique role that information systems can play in multilevel research, and offer guidance on how IS researchers can uniquely add to the discourse on the multilevel research paradigm. We contribute to the IS literature in several ways. First, we discuss how to identify the multilevel nature of IS studies. Second, we distinguish between explicitly stated and implicitly conducted multilevel research in IS, and we examine the related issues and consequences of implicit designs. Third, we provide guidelines for developing and evaluating explicitly multilevel IS research. These guidelines should facilitate and encourage IS researchers to become more involved in multilevel research, as has occurred in other disciplines, by urging them to consider the potential multilevel nature of their future research. Fourth, we articulate IT's unique role in developing multilevel opportunities for IS researchers. Fifth, and finally, we present several research questions to encourage researchers to take advantage of multilevel IS research opportunities.

The paper is organized as follows. In Section 2, we review multilevel research perspectives from the management literature and propose a framework for analyzing multilevel research in the literature. In Section 3, we discuss multilevel concepts as applied to IS research, specifically addressing the role of technology. In Section 4, we review multilevel research in IS. In Section 5, we elaborate on the findings from this review. In Section 6, we discuss opportunities for multilevel research in IS and, in Section 7, we conclude the paper.

2. Background

What is multilevel research? To answer this question, we first turn to the management literature and discuss various perspectives on multilevel research. In discussing these perspectives, we provide a variety of relevant definitions. However, given our focus on IS research, we then apply these definitions to the IS domain by examining possible multilevel entities and concepts more specifically related to IS, including the role of IT in multilevel research.

2.1. Multilevel Research Perspectives

Several perspectives regarding multilevel research exist in the management literature, and each contributes to our understanding of multilevel research. We turn to this previous work, summarized in Table 1, to frame our discussion. The first two perspectives suggest there are two fundamental levels to multilevel organizational research: individual (or micro) and collective (or macro) (Klein, Dansereau, & Hall, 1994; Kozlowski & Klein, 2000; Morgeson & Hofmann, 1999). The micro perspective usually focuses on an individual's behavior or perceptions, and the macro perspective focuses on some larger entity, aggregate, or collective, be it a dyad, team, group, organization, or industry. This perspective also suggests that multilevel studies are those that consider actions of the individuals and actions at the collective level of analysis. These collectives are defined as "open interaction systems, where action and reactions determine the structure of the systems. These collectives then interact, composing yet larger collectives" (Morgeson & Hofmann, 1999, p. 251).

[1] While the review by Hitt et al. (2007) covers a shorter time period than our review, the reader will note that the percentages mentioned above (10% of IS papers) would be even smaller if we did not include recent years (2008-2010), which account for more than 50% of the multilevel studies in IS in our review.

Table 1. Various Perspectives on Multilevel Research

Perspective	Description	Sources
Individual & collective	The **collective** represents "any interdependent and goal-directed combination of individuals, groups, departments, organizations, or institutions". Collective constructs have their own "structural properties that can exert influence that is independent of the interaction that initially caused the construct to emerge" (p. 251).	Morgeson and Hofmann (1999)
Micro coupled with macro	**Micro perspective** focuses on individuals and groups. **Macro perspective** focuses on organizations, environments, and strategies. IS researchers need to consider both levels simultaneously and include the macro perspective because of the transformational aspects of IT.	Agarwal and Lucas (2005), DeShon, Kozlowski, Schmidt, Milner, and Wiechmann (2004), Kozlowski and Klein (2000)
Mixed models	**Composition models** exist where there are relationships among nondependent variables at different levels (e.g., the psychological climate at the individual level and organizational climate at the unit level). **Cross-level models** involve relationships between dependent and independent variables at different levels. In this case, a causal relationship exists between a phenomenon at one level and another at a different level. **Multilevel models** refer to relationships between dependent and independent variables that can be generalized across two or more levels. These are broad models and include composition and cross-level models.	Chan (1998), Rousseau (1985)
Testing entities vs. variables	To test **entities** and **variables**, researchers may hypothesize relationships that are unique to a lower level (level specific), emergent at a higher level only, or cut across multiple levels simultaneously (cross level).	Dansereau, Alutto, and Yammarino (1984), Dansereau, Cho, and Yammarino (2006), Markham and McKee (1995), Markham et al. (2010)

In the third perspective, Rousseau (1985) offers a typology focused on how constructs from different levels might be related. She proposes three types of mixed-level models: composition models, cross-level models, and multilevel models. Finally, the fourth perspective suggests a multilevel researcher is concerned with:

1) identifying entities that can be characterized as whole units or parts (a within-unit perspective) and,

2) characterizing relationships as a function of the hypothesized units.

In this paper, we apply a multilevel lens adapted from Morgeson and Hoffman (1999), and we include terminology from Klein, Dansereau and Hall (1994) and key concepts from Dansereau et al. (1984, 2006) to build an inclusive viewpoint for these different multilevel perspectives that moves beyond Morgeson and Hoffman's perspective alone. We define multilevel research as research that:

1) investigates phenomena at minimally two (nested) levels or entities

2) hypothesizes relationships that emerge in and/or across different (nested) levels of analysis, and

3) considers these nested levels or entities in theory building, hypothesis development, research design, data analysis, and interpretation of findings.

Table 2 presents the starting point for our review and analysis of multilevel research in IS, which we discuss in Section 3. We adapted Table 2 from Dansereau et al. (1984), who suggest that six key phases are needed to conduct multilevel studies. The proposed framework in Table 2 summarizes our perspective and presents guidelines for conducting multilevel quantitative research in IS. The phases in the framework provide a general foundation for multilevel research that could be applied to almost any field studying multilevel issues, whether management, IS, or others. Having such a general framework is useful, but it is also important to understand whether the framework should or could be applied in unique ways in IS research. For instance, is there anything specific or unique about IS that could (or should) lead researchers to carry out the phases in the framework in a specific way? Before presenting our review of multilevel IS studies and our application of this framework in Section 4, we discuss the existence of entities and concepts specific to the IS domain.

Table 2. Phases of Research for Multilevel Studies (Dansereau et al., 1984)

Phase	Description
1. Research topic formulation	Topics are based on contributions from the practitioner domain and from academic sources, where the most fundamental and basic set of interest areas or problems are articulated. The key issue is to identify the general research question or problem to be addressed.
2. Entity specification	Any possible, naturally occurring entities within the boundaries of the general research question are identified. For example, does the general research question imply that pre-existing supervisory groups and their members are part of the context that should be considered? Does it imply that temporary virtual teams and their members should be tracked? Is a new entity, such as a website or a database, the locus of attention?
3. Variable specification	Hand-in-hand with the specification of entities is the selection of constructs and their operationalization. Though previous research can be a guide to current measures, new variables maybe required. Not all variables can simply be aggregated to larger and larger entities and retain the same meaning as at more granular levels.
4. Theory specification	In conjunction with the entities and variables, the underlying theory needs to be elucidated so that (a) past research findings can be brought to bear and (b) the underlying process and dynamics of how the variables operate at different levels can be articulated. Thus, the theoretical formulation will often provide more depth and insight than what can be directly measured by the variables in question. It should also suggest the boundary conditions for which the hypothesized relationships should be expected versus those conditions where no relationship is expected. When the context is clearly identified, the task of determining similarity of the research setting to that of past studies becomes easier.
5. Research design specification	The research in question might be conceptual or empirical. If it is an empirical study, then it could be either qualitative or quantitative. Further, the research may be cross-sectional, longitudinal, or some variation of a laboratory or field experiment.

Table 2. Phases of Research for Multilevel Studies (Dansereau et al., 1984) (cont.)	
Phase	**Description**
6. Analytical technique selection	Both overt and subtle differences exist in the various types of empirical tests and techniques that can be used to assess multilevel hypotheses. Some rely on analysis of variance (ANOVA) designs, some on ordinary least squares (OLS) designs, and others on structural equation modeling (SEM) designs. Thus, the easiest path might be to use a specialized multilevel package such as HLM (Raudenbush, Bryk, Cheong, & Congdon, 2006), MLwiN (Rasbash, Steele, Browne, & Goldstein, 2009), MPlus (Muthen & Muthen, 2007) or DETECT (Dansereau & McConnell, 2000) in which the logic of matching the statistics with the inferences is built into the software. However, more general statistical packages such as SPSS, SAS, and R can also be used with some additional effort. What is critical is the correct specification and use of relevant statistical tests, and how well they match the multilevel inferences, regardless of the particular software package used.

3. Multilevel Concepts in IS Research

Organizational researchers have previously identified entities of interest to include individuals, dyads, groups, projects, strategic business units, organizations, industries, and societies—with appropriate nesting (i.e., individuals within groups, individuals or groups within organizations, and so on). In addition to these levels, based on the types of collectives and relationships that Klein and Kozlowski (2000) identify, there are inter-group relationships and inter-organizational relationships as additional entities of interest. While this may represent a reasonably exhaustive list for organizational researchers, IS researchers study people and technology. Are there entities or levels specific to IS research? We argue that there are and contend that the multilevel paradigm presents a major opportunity for IS researchers to better understand the core of our field, which we illustrate in the following paragraphs.

Multilevel research in organizational studies investigates individuals and collectives (or lower-level entities and higher-level entities) comprised of just one type or source: human actors (i.e., people). Such types of organizational studies are referred to as mono-compositional; that is, they are composed of nested entities of one type: people. However, multilevel IS research, at its very basic level, should extend this to consider an IT entity separately (also a mono-compositional model) or IT in conjunction with people (a mixed-compositional model). An IT entity represents “an identifiable technology-related element” or “component that exists on its own”. It can be an independent system in its own right, or it can be a subsystem that is part of a near-decomposable system as Simon (1996) defines it. We provide a number of examples of IT entities in Section 3.1. IS researchers engaged in multilevel research must be aware that either the human entities or the IT entities can operate at the individual level, or at a higher, collective unit of study.

3.1. IT as Source of Entities

Collective constructs can emerge from lower-level constructs via context and process (Morgeson & Hofmann, 1999). Context refers broadly to the situation within which lower-level entities interact and thus have the potential to form a collective unit; processes typically entail either an inevitable, time-based evolution or an event-driven emergence of a collective. Previous multilevel studies have often relied on formal structures (embodying both context and process), such as designated members of a team or fulltime employees of an organization (Mathieu & Chen, 2011). Such collectives were argued to exist because individuals within them shared a common fate (subject to the same influences and outcomes), physical proximity, and/or pregnance (having defined and closed boundaries over time) (Campbell, 1958). Applying this understanding of how collectives emerge to form IT entities, researchers may consider whether IT acts as cohesively as entities or merely provides structure that supports the time-based or event-driven emergence of a collective (e.g., a group or team). If an IT

system (or subsystem) is considered an entity, then it may be treated as a collective and specifically evaluated as part of the research design as opposed to be tolerated as part of the research environment.

We turn to the literature on organizational routines to offer a theoretical basis for exploring the question of when IT systems or subsystems should be considered entities. Organizational routines (i.e., repetitive, recognizable pattern of interdependent actions carried out by interdependent actors) include ostensive (or ideal/schematic form) and performative (or specific action) aspects (Latour, 1986; Pentland & Feldman, 2005). For many organizational routines, the ostensive aspect is the information system. For example, organizations spend millions of dollars on ERP systems often for the embedded business processes (or routines) that are part and parcel of the overall system. Further, the interdependent nature of the actors involved in organizational routines suggests a distinct entity may form around these routines. For example, collectives may form around various ERP modules (e.g., the materials acquisition group may form around the materials management module). As such, the subsystem level (i.e., the performative aspect of the routine) would be nested within the larger system level (i.e., the ostensive aspect). In this example, the system is an entity. The collective formed because of the technology. ERP systems represent a prime case of "systems as entities" because ERP implementation is so often done by changing the organization's work practices and structures to conform to the system. The separate modules could also be the entity of interest if there were substantial variability in their implementation success.

Not all IT artifacts can necessarily be considered entities of interest for testing purposes. Hence, the context within which lower-level entities (such as individuals) interact may simply be supported by IT systems. Such support may facilitate both time-based and event-driven emergence of collectives. For example, IT usage is an activity composed of two fundamental elements: a system and a task performed by a user (Burton-Jones & Straub, 2006). Recent work on IT usage patterns suggests that IT usage events can either be routine or in response to the unexpected (Ortiz de Guinea & Webster, 2013). Routine IT events such as online collaborations or use of desktop applications enable users to stay focused on their task, and the technology simply provides structure for time-based or evolutionary collective emergence. Such emergence while facilitated (at least partially) by IT is unlikely to be conceptually changed by the technology. In this example, the IT "system" is not a distinct entity: rather, it simply provides structure to facilitating the process.

3.2. Combining People and Entities in IS Research

When a study focuses on both types of human and IT entities, the resulting combinations of mono-compositional or mixed-compositional models can prove especially challenging (see Figure 1). Further, as in organizational studies, there may also be higher-level aggregations and relationships resulting in combinations of groups of people nested within larger groups and IT subsystems or systems nested within these groups. As such, while it might be comforting to think there is some finite (and identifiable) number of combinations of people and systems that define the multilevel space for IS researchers, such thinking is likely shortsighted. However, understanding mono-compositional and mixed-compositional models and how they apply to IS research can help guide future research efforts.

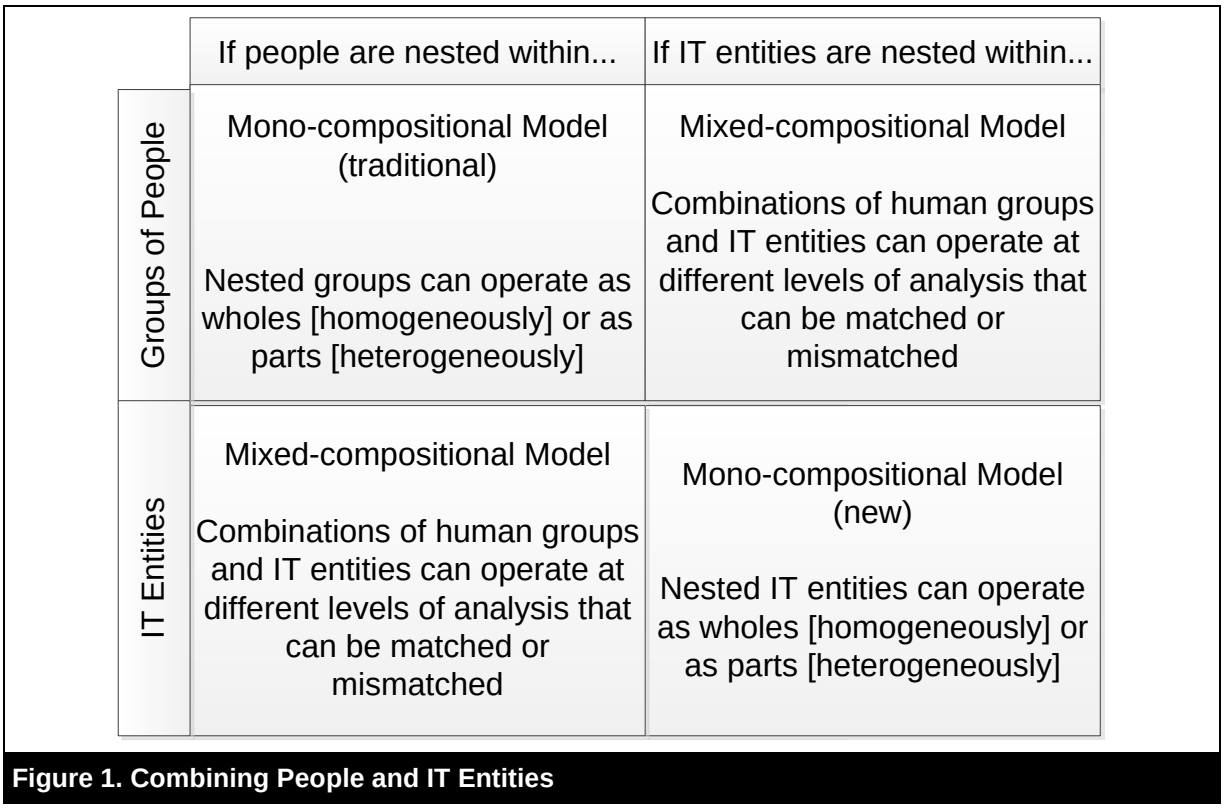

Figure 1. Combining People and IT Entities

3.3. Mono-compositional Models (Traditional Models)

Within IS, some research questions may be best investigated using traditional models that have one class of entity (e.g., nesting people within large collectives of people). A traditional example in IS can be found in Levina and Xin (2007), who investigated IT compensation within and across countries. In this case, they did not investigate an "IT system". In another example, Cummings, Espinosa, and Pickering (2009) investigated globally distributed project teams. These authors focused on the use of collaborative technologies across time and space. However, the project teams (i.e., collectives) were formed due to project needs; as such, the IT system provided a facilitating condition for these collectives to form, but was not a distinct entity. Had these authors investigated 1) subgroup formation around certain technologies or features, 2) teams whose membership was determined by technology features, or 3) project-related procedures developed by the teams that were captured and enacted by the system, then the collaborative technology would be an entity.

Similarly, Kane and Borgatti (2011) explored the relationship between individual IS proficiency, variability in individual IS proficiency, and group performance using social network analysis. Specifically, they examined the configuration of individual proficiency within groups such that the more central the high performers are within the group (a form of dispersion analysis), the better the group performs, on average. Finally, Jasperson, Carter, and Zmud (2005) propose a theory of post-adoption use by identifying individual adoption decisions within the context of organizational action. As these authors propose, the model is a traditional homogeneous model. Interestingly, these authors label the organizational action as a "work system", but largely define the system as norms and expectations on the part of management. However, they do reference "technology features that enable or support work tasks and processes" as part of the work system (p. 535). Researchers investigating this particular aspect of the work system likely need to view their phenomenon as a mixed-compositional model.

3.4. Mono-compositional Models (New Models of Nested IT Subsystems)

Mono-compositional models of IT subsystems nested within larger IT systems have not been considered previously within IS research, but they represent an opportunity for IS researchers. For

example, system quality and information quality are well-studied constructs in IS research[2]. However, if they were investigated at multiple levels, researchers could potentially develop new insights. For example, the way in which consumer billing invoices are produced by a large, national telephone company could be considered as a complex, multilevel hierarchical production factory (Markham and Grove, 1997). Each month, millions of invoices would flow through this factory, which is physically distributed across many mainframes around a country. Major processes, such as call collection, would occur in several modules (e.g., applying call rates and appropriate taxes to each invoice). These modules would then have embedded processes that could be studied and visualized (Markham, 1998) in much the same way that a machine could be evaluated on a manufacturing floor. At each level of analysis, one could ask about the speed of processing, the error rate, the ability to monitor, and so on. Such investigation could be accomplished without including or referencing a human entity.

3.5. Mixed-compositional Models

Mixed compositional models of groups of people nested within IT entities or IT entities nested within groups of people are also new ways to consider multilevel research that IS researchers are uniquely qualified to study. While IS researchers might have been sensitive to multilevel research using a mono-compositional model of people nested in collectives of people, there is little in our sample of papers (see Section 4) suggesting IS researchers are sensitive to the role the IT entity can and should play in the specification of a multilevel model.

A mixed model might be useful when studying the development, management, or use of systems; especially when researchers are interested in systems and multiple people interacting with each one (e.g., developing, managing, or using it). In this case, people are nested within IT entities. For example, Rai, Maruping, and Venkatesh (2009) studied off-shore, IS project success. They identify the project and project leader as two different levels or entities but do not include the "system" as an entity. They do include control variables that might be seen as surrogates for the system: project complexity, requirements uncertainty, and project size. However, including the system as a level or entity rather than control variables would have allowed these researchers to include in their analysis an investigation of the differential impacts of the systems being developed.

Alternatively, IT entities may be nested within groups of people. For example, data within different systems can provide the basis for a person's overall memory or knowledge of a particular event, process, and so on. Griffith, Sawyer, and Neale (2003) develop a theoretical model about knowledge transfer in virtual teams. Building on Nonaka's (1994) spiral of knowledge, they suggest that individual knowledge is codified into the team's shared practices and transactive memory systems, and this team-level knowledge is aggregated into organizational-level knowledge that is fed back to inform individuals. However, they do not offer propositions about how organizational knowledge may constitute individual knowledge. Researchers interested in how organizational knowledge—in the form of a knowledge management system—provides the basis for individual knowledge likely would study such phenomenon using a mixed-compositional—IT entity nested within people—model.

3.6. Decomposable Hierarchies, System Complexity and Findings across Levels

The previous examples notwithstanding, IS research oftentimes involves more than two levels and likely encompasses greater system and subsystem complexity (e.g., people nested within groups of people and IT systems or subsystems nested within individuals or groups of people). This view aligns well Simon's (1996) in his discussion of hierarchical systems. On one hand, some systems can be described as wholes and cannot be reduced into their subsystems in a meaningful way (Simon, 1996 p. 170). However, most social systems are forms of nested hierarchies that possess the property of "near-decomposability" so that some processes can occur among whole subsystems at higher levels, whereas other processes can occur within subsystems at lower levels (Simon, 1996 p. 196). Dansereau et al. (1984 p. 14-15) have termed processes that can be detected only at higher levels as emergent processes and those that can be found only at lower levels as "level-specific" processes. Both are

[2] We thank an anonymous reviewer for suggesting this example.

possible configurations of organizational systems that run counter to the "homology[3]" thesis. In a recent IS example, researchers questioned whether communities developed different sets of privacy concerns at the collective level from those at the individual level (Bélanger & Crossler, 2011). This question explicitly runs counter to the homology assumption. Further, consider studies of virtual teams, where some of the work (e.g., Carte & Chidambaram, 2004; Dennis, Fuller, & Valacich, 2008) suggests that collaborative technologies should be studied at the capability or feature level (i.e., IT subsystems nested within IT systems), and the teams are often conceptualized as a within-unit effect with individuals nested within teams. These teams could then be nested within departments. Such research efforts should take special care to determine the entities involved and the nature of the nesting.

In addition to issues of hierarchical nesting, researchers must also take care to carefully consider whether the multilevel phenomenon of interest is best studied between or within entities. Continuing our example of an IS researcher interested in exploring an ERP system as the focal unit of interest, the researcher could ask a question such as: what explains the differences in success rates of implementations of ERP applications? As such, it is the variability between ERP systems (and the organizations that host them) that would be of interest in this situation. At a minimum, this would imply that, among the competing organizations, the variability and covariability in ERP success and firm performance would be of paramount interest. Quite understandably, this view focuses on firms as whole entities and would employ between-entity analysis to address research questions. However, the multilevel researcher could instead be interested in how lower-level entities such as ERP modules or subsystems impact implementation success and thereby adopt a within-entity perspective. Figure 2 illustrates this example.

In Figure 2, the line running in the background represents a regression line for all three levels illustrated. Each level is shown as potentially independent and "testable". The first two levels show a between-entity relationship (based on both variance and covariance) for the two variables of interest (installation success and performance). Because a whole entity effect is shown, we can talk about differences between organizations (or plants) and how organizations that are, on average, high on one variable are also high on the other. The lowest level shows a within-entity effect for two variables (decisions and routines). At the lowest level, if the elements (i.e., dots) are people, then this figure shows a mixed-compositional model with people nested within technology. Because it is a "within-unit" view, we are looking at the speed of decisions and the quality of the routines compared to the average for that particular module. If the elements are automated decisions or routines, then it is a mono-compositional model with just IT entities. In the example, it is the dialog, decisions, and information sharing within modules that help explain what happens at higher levels of analysis[4].

[3] The homology thesis or homologous multilevel research assumes consistency across some or potentially even all subgroups or lower-level entities.

[4] Each entity at a higher level would have its own nested "child" entities, which are not shown directly but suggested by the single rotated parenthesis symbol. In other words, we are testing each level as a distinct entity across all of the nested levels; we are not testing a cross-level effect.

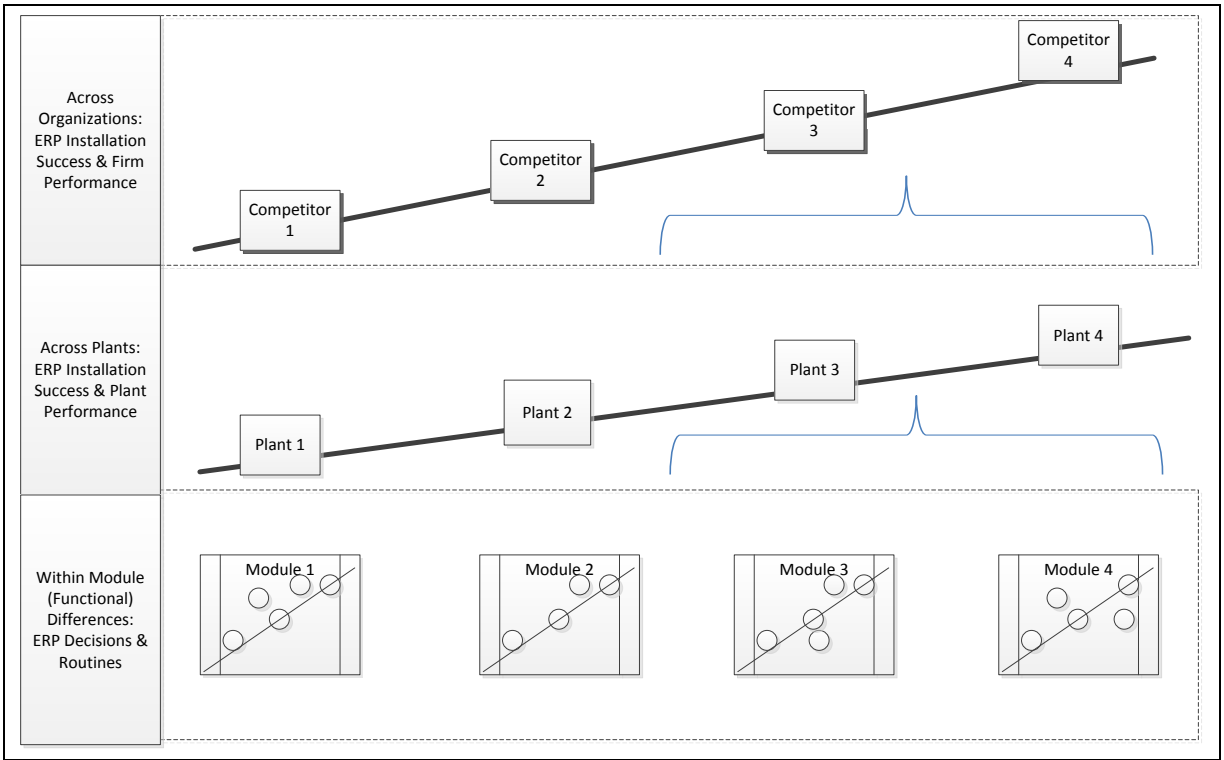

Figure 2. An Illustration of IT Systems as Entities

While our above examples may suggest that there are clear cases in IS research to guide the practice of multilevel IS research, our targeted review of the literature suggests substantial work is still needed. An effort to develop a clearer understanding about the best practices for conducting multilevel IS research in our field has the potential to both inform IS researchers and to push the boundaries of the multilevel paradigm emerging in other disciplines.

In Section 4, we explore how IS researchers have carried out the different phases of multilevel research proposed in the framework (Table 2). In doing so, we also seek to understand how IS researchers might have considered the more novel and IS-specific extensions to multilevel research we discussed in this section by looking at the different roles that technology can play.

4. A Targeted Review of Multilevel Research in IS

To conduct the review, we performed a three-stage document analysis described in depth in Appendix A. Given that we discuss the issues, the literature, and provide guidance on the use of multilevel research in the IS field from a quantitative research approach, we limited our search to two leading journals in the field: *Information Systems Research* and *MIS Quarterly*. These journals rank consistently among the top publication outlets for research in IS. As such, the state of multilevel research suggested by publications in these journals should be an appropriate surrogate for the state of multilevel research in the field. Though we recognize that excellent articles using multilevel analyses are published in other journals, selecting these two journals was necessary to limit the overall number of papers because the review involved several rounds of document analysis for all papers in the sampling frame in order to differentiate between explicitly stated multilevel research and implicitly conducted multilevel research. As a result, we do not claim to have an exhaustive list of multilevel articles.

In the first stage of document analysis, one researcher examined all papers published between March 2002 and December 2010 and eliminated those that clearly followed an approach where a single-

level of analysis was assumed and/or used. A total of 526 journal papers were reviewed in stage I of the analysis, which Table 3 shows.

Table 3. Published Multilevel Papers in MISQ and ISR from 2002 to 2010

	MISQ	ISR	Total
Number of papers reviewed	284	242	526
Explicitly stated multilevel papers	16	6	22
Implicitly conducted multilevel papers	17	12	29
Total multilevel papers	33	18	51
Percent of published papers	11.6%	7.4%	9.7%

As we note earlier, we identified multilevel research as research that examined and reported results at minimally two (nested) levels or entities. Therefore, we coded papers using statistical methods such as hierarchical linear modeling, r_{wg}, and intra-class correlation to present individual data as part of an aggregate measure of a macro level construct as multilevel only if they hypothesized and reported results with some combination of levels or entities. From screening the 526 papers, we found a potential set of 79 multilevel papers. Note that, while the papers included in our review met the criteria we set out in our definition of multilevel research, the authors of these papers may not have intended to (nor retrospectively think that they had) conduct multilevel research. However, we believe such a gap between our categorization of these papers and the authors' potential categorization is further evidence of the need for IS researchers to be more aware of multilevel practices and to be held more accountable for the language they use to describe the theory and design of their studies.

In stage 2 of the document analysis, a different researcher evaluated the 79 papers initially identified as multilevel to confirm the multi-level classification. On completion of the second round of analysis of these documents, we removed 28 papers from the list of potential multilevel papers. A minimum of two (but often three) researchers then jointly coded the remaining 51 papers; we discussed disagreements until we agreed. We used the framework presented in Sections 2 and 3 (Table 2) to identify the coding categories and evaluate the current state of IS multilevel literature. A complete list of coding elements is presented in Table A-1 (Appendix A).

Tables 4 to 6 present the results of the coding process. While our discussion focuses on quantitative research, we coded qualitative and conceptual papers in the sample in order to obtain a broader view of the overall state of multilevel research in IS. For the purpose of discussing the studies in the context of the phases in the framework, however, we focus on the quantitative approach to conducting multilevel research. At the same time, as we note in the upcoming discussion, it is important to realize that qualitative, quantitative, and conceptual research can also serve to inform each other. In Section 5, we discuss the results presented in Tables 4 to 6. We then use these findings in our discussion of suggested opportunities for multilevel research in IS in Section 6.

Table 4. Quantitative Studies

			Entities of interest				Research topics				
Authors	Journal	Explict ?	Individual	Dyad or group	Org., website, project, etc.	Others (industry, nation, community etc.)	IT development	Initial use	Continued IS use	Knowledge management & sharing	Collaboration
Agerfalk & Fitzgerald, 2008	MISQ		*			*	*				
Balijepally, Mahapatra, Nerur, & Price, 2009	MISQ	✓	*	*			*				
Bapna, Chang, Goes, & Gupta, 2009	MISQ	✓	*			*			*		
Chen & Hitt, 2002	ISR		*		*				*		
Chidambaram & Tung, 2005	ISR		*	*							*
Cummings et al., 2009	ISR	✓	*	*							*
Cyr, Head, Larios, & Pan, 2009	MISQ		*			*	*				
Dewan, Ganley, & Kraemer, 2010	ISR					**			*		
Gu, Konana, Rajagopalan, & Chen, 2007	ISR		*	*	*	*					*
Hahn, Doh, & Bunyaratav, 2009	MISQ	✓			*	*			*		
Iacovou, Thompson, & Smith, 2009	MISQ		*	*		*	*				
Jarvenpaa, Shaw, & Staples, 2004	ISR		*	*							*
Jones, Ravid, & Rafaeli, 2004	ISR		*	*							*
Levina & Xin, 2007	ISR	✓	*		*		*				
Li & Hitt, 2010	MISQ				*	*			*		
Liu, Ray, & Whinston, 2010	ISR	✓	*		*	*				*	
Moon & Sproull, 2008	ISR		*	*							*
Rai et al., 2009	MISQ	✓	*	*			*				
Sarker & Valacich, 2010	MISQ	✓	*	*							*

Table 4. Quantitative Studies (cont.)

			Entities of interest				Research topics				
Authors	Journal	Explicit ?	Individual	Dyad or group	Org., website, project, etc.	Others (industry, nation, community etc.)	IT development	Initial use	Continued IS use	Knowledge management & sharing	Collaboration
Sen, Raghu, & Vinze, 2009	ISR		*		*				*		
Sharma & Yetton, 2007	MISQ		*	*				*			
Sherif, Zmud, & Browne, 2006	MISQ		*		*		*				*
Wakefield, Leidner, & Garrison, 2008	ISR		*	*							*
Weitzel, Beimborn, & Konig, 2006	MISQ		*	*							*
Notes: ** Entities were technology and country											

Table 5. Conceptual Models and Commentaries

			Entities of interest				Research topics				
Authors	Journal	Explicit ?	Individual	Dyad or group	Org., website, project, etc.	Others (industry, nation, community, etc.)	IT development	Initial IS use	Continued IS use	Knowledge management & sharing	Collaboration
Burton-Jones & Gallivan, 2007	MISQ	✓	*	*	*				*		
Butler & Gray, 2006	MISQ	✓	*		*				*		
Griffith et al., 2003	MISQ	✓	*	*	*					*	
Jasperson et al., 2005	MISQ		*		*				*		
Leidner & Kayworth, 2006	MISQ	✓	*	*	*	*		*			
Lyytinen & Yoo, 2002	ISR	✓	*	*	*	*	*	*	*		
Melville, 2010	MISQ		*			*	*				
Tilson, Lyytinen, & Sorensen, 2010	ISR	✓	*	*	*	*			*		
Yoo, 2010	MISQ		*	*	*	*			*		

Table 6. Qualitative or Action Research Studies

			Entities of interest				Research topics				
Authors	Journal	Explict ?	Individual	Dyad or group	Org., website, project, etc.	Others (industry, nation, community, etc.)	IT development	Initial IS use	Continued IS use	Knowledge management & sharing	Collaboration
Avgerou & McGrath, 2007	MISQ		*		*			*			
Braa, Hanseth, Heywood, Mohammed, & Shaw, 2007	MISQ		*		*	*		*			*
Davidson, 2002	MISQ		*	*			*				
Garud & Kumaraswamy, 2005	MISQ	✓	*	*	*					*	
Lamb & Kling, 2003	MISQ	✓	*	*	*	*			*		
Lapointe & Rivard, 2005	MISQ	✓	*	*				*			
Levina, 2005	ISR	✓	*		*			*			
Lindgren, Henfridsson, & Schultze, 2004	MISQ	✓	*		*		*				
Markus, Steinfield, Wigand, & Minton, 2006	MISQ	✓			*	*					*
Miscione, 2007	MISQ		*	*	*	*			*		
Nickerson & Muehlen, 2006	MISQ		*	*	*						*
Puri, 2007	MISQ		*	*		*				*	
Schultze & Orlikowski, 2004	ISR		*		*				*		
Strong & Volkoff, 2010	MISQ	✓	*		*			*			
Thomas & Bostrom, 2010	MISQ		*	*							*
Vaast & Walsham, 2009	ISR		*			*		*			
Vannoy & Salam, 2010	ISR		*		*				*		
Wang & Ramiller, 2009	MISQ	✓			*	*		*			

5. Findings

As we state in Section 4, the analysis revealed that many authors do not specifically state the level(s) or entity(ies) of their studies' analysis, nor do they specify their studies' multilevel or cross-level considerations. As we discuss the findings from our coding, we highlight differences between papers that were explicitly multilevel (i.e., the authors clearly identified their work as multilevel) versus

implicitly multilevel (i.e., the authors included constructs captured at different levels or entities but may not have recognized or noted the multilevel nature of their work). We organize our discussion using the framework used for the review (Table 2).

5.1. Phase 1: Research Topic Formulation

Our review and analysis of IS papers presented in Tables 4 to 6 revealed five broad themes:

1) information technology (IT) development
2) initial IS use
3) continued IS use
4) knowledge management and sharing, and
5) collaboration.

Table 7 describes these topic areas.

Table 7. Research Themes in Multilevel IS Papers

Theme	Description
IT development	Research that focuses on the creation, design, and "architecting" of IT systems.
Initial IS use	Research that focuses on the introduction of the system to the end users after its design.
Continued IS use	Research that investigates the on-going and evolving impacts of IT on individual use behaviors or beliefs, or of other factors on of the use of IT systems by users.
Knowledge management and sharing	Research that examines the dynamics of information creation, collection, or sharing.
Collaboration	Research that focuses on the interaction and the technology among two or more people in pursuit of a common goal or work deliverable.

Of the studies (22 of 51 papers; Tables 4 to 6) that explicitly researched a phenomenon using a multilevel framework, five studied IT development concepts, and three of those five conducted quantitative multilevel research (Table 4). Examples of quantitative multilevel research on IT development include studies of the performance of individuals in dyads (Balijepally, Mahapatra, Nerur, & Price, 2009), individual compensation within firms (Levina & Xin, 2007), and development teams in organizations (Rai et al., 2009). However, there were several quantitative studies (four of seven) of IT development that do not explicitly state the multilevel nature of their work (see Table 4), such as a study of IT development that compares findings across countries (Cyr, Head, Larios, & Pan, 2009) or a study investigating the impacts of individuals' and organizations' actions on collective constructs, such as an organization's IT development and reuse (Sherif, Zmud, & Browne, 2006).

Continued IS use had two quantitative studies explicitly recognized as multilevel. These explored market level conditions' impacts on individual bidder behaviors (Bapna, Chang, Goes, & Gupta, 2009) and environmental level risk perceptions' impacts on firm-level risk outcomes (Hahn, Doh, & Bunyaratavej, 2009). Both of these studies present examples of top-down multilevel impacts (collective phenomena impacting individual-level phenomena). It is surprising that there were not more explicit quantitative multilevel studies on continued IS use, especially those using bottom-up approaches (i.e., individual-level phenomena's impact on collective phenomena) given the existing multilevel frameworks for IT usage (Burton-Jones & Gallivan, 2007; Butler & Gray, 2006) and several calls for such research (e.g., Lyytinen & Yoo, 2002; Tilson, Lyytinen, & Sorenson, 2010; Yoo, 2010).

We note, however, that some studies do implicitly perform this kind of research without explicitly recognizing it (e.g., Li & Hitt, 2010; Sen, Raghu, & Vinze, 2009). Because the development of conceptual frameworks for continued IS use appears to be a major focus (four of six conceptual papers on continued IS use explicitly include multilevel concepts as can be seen from Table 5), it is likely that we will see more quantitative research leveraging these frameworks in the future.

In terms of collaboration research, there were few quantitative studies (two of 10) that explicitly conduct multilevel research (Table 4). Addressing the need to better conceptualize group level phenomena, Sarker and Valacich (2010) specifically discuss the use of non-reductionist approaches in investigating group-related phenomenon in the context of technology adoption; they emphasize that group technology adoption should not be studied with the paradigm of methodological individualism. Cummings et al. (2009) study the coordination of individuals in pairs (dyads) within projects. One of the issues with many multilevel quantitative research studies is not only that researchers do not recognize the multilevel nature of their work (eight of 10 papers), but also that many identify their studies as group-level though these are not actual group-level studies (we discuss this further when discussing aggregation issues in the data analysis phase later on). The most common multilevel approach in this set of papers considers the group or dyad and its impact on individual behavior within a group/team and, subsequently, how individual behavior in turn influenced dyadic/group-level outcomes. For example, Sherif et al. (2006) found that organizational level attributes (coordination mechanisms and organization learning) influenced individual perceptions (conflict), which in turn affected organizational outcomes (reuse program outcomes).

The last two themes have few overall studies. There was only one study on initial IS use from a quantitative perspective, but the authors did not explicitly recognize the multilevel nature of their work (Table 4). Sharma and Yetton (2007) used a meta-analysis to discuss the impact of individual cognitions on inter-individual cognition—a unit-level phenomenon manifested as collaborative task knowledge and transactive memory systems. There was also only one study in the knowledge management category for quantitative papers, and it was explicitly conducted as a multilevel study (Table 4). Liu, Ray, and Whinston (2010) studied individuals in networks to examine the interaction between knowledge codification and knowledge sharing. It is surprising, again, that there were not more studies of individuals within groups in the context of knowledge management or even experience within groups. Furthermore, existing knowledge management research describes, especially from a theoretical perspective, how knowledge accumulation and documentation processes can potentially unfold within and between entities. A conceptual paper to this effect starts to unravel the potential multilevel nature of knowledge management (Griffith et al., 2003). Extending these concepts, we propose that the identification of databases, warehouses, and electronic knowledge repositories as unique and distinct entities of interest supports the application of a multilevel lens.

Researchers interested in complex IS phenomena that are likely to involve constructs and effects at multiple levels of analysis should clearly formulate their topic to include the various entities of interest. In the IS field, many topics are good candidates for multilevel research and would benefit from using a multilevel lens, which we discuss in Section 6.

5.2. Phases 2 & 3: Entity and Variable Specification

Once a topic has been formulated, researchers need to perform entity and variable specification, which entails identifying entities and variables of interest in order to explore the selected multilevel topic. Because specifying entities and variables are coterminous, we discuss them both here.

In our review of the IS multilevel literature, we found that researchers, whether conducting multilevel research or not, often do not clearly identify their unit of analysis. Of further concern, our review indicated that authors typically fail to identify both the unit of analysis and the level of measurement. IS researchers should not assume that the units are so obvious based on the research conducted that it is not necessary to specify them. Our finding supports prior calls in organizational behavior literature for authors to be more specific regarding the basic characteristics of their research.

Previous work highlights failings in reporting setting, context, timeframe, and industry in which research was conducted (O'Leary & Almond, 2009; Rousseau & Fried, 2000). We add a call for entity specification as well.

Variable specification is as important to multilevel research as entity and level of measurement specification. Researchers must not only specify which variables are of interest to the research, but also the level at which these variables are conceptualized. For example, performance of the group is different from performance of the individual. The researcher must specify which of the two is explored, measured, and subjected to inferences. In our review of multilevel IS papers, we found that researchers did a good job in general of specifying the variables or constructs they were interested in studying (all studies identify their constructs). However, they often fail to specify the level at which they studied the variable. As we discuss in Section 3, some variables exist at specific levels, such as group cohesion or group memory at the group level or earnings per share at the corporate level. However, most studies using perceptual measures employ individual level variables even if considering entities other than individuals. In our review (Tables 4 to 6), 31 of the 51 multilevel studies focus on the individual and only one other entity (e.g., groups or organizations). Furthermore, from a construct perspective, multilevel research would suggest that we should not only conceive constructs that result from an aggregation, but also constructs that exist on their own at the collective level (e.g., Chen, 2005). As we discuss in Section 3, examples of such constructs, also referred to as "global" constructs (Kozlowski & Klein, 2000), include team cohesion or team age.

Several issues can result from a failure to consider the multilevel nature of one's research, and the importance of proper entity and variable specification in multilevel research cannot be overstated. In developing a multilevel framework for IS usage, Burton-Jones and Gallivan (2007), building on the work of Morgeson and Hofmann (1999), highlight the main fallacies that can result from inadequate conceptualization of a multilevel phenomenon as follows:

- Cross-level fallacy poses a threat to construct validity and occurs when researchers "neglect to specify the underlying mechanisms by which individual-level phenomena (e.g., individual system usage) give rise to higher-level phenomena (e.g., organizational system usage)" (Burton-Jones & Gallivan, 2007, p. 660). In fact, cross-level fallacies may occur when researchers fail to recognize the effects of processes that build interdependencies between individuals.

- Contextual fallacy poses a threat to internal validity and occurs when researchers obtain spurious relationships at a lower level (e.g., a positive relationship between individual system usage and individual performance) because they fail to account for higher-level factors that impact the relationship (e.g., group norms). An empirical example of an organizational study of the effect of supervisory group structure on merit raises illustrated this fallacy and the inherent dangers of drawing wrong conclusions when context is not applied correctly (Markham, 1988).

- Ecological fallacy poses a threat to external validity and occurs when researchers "incorrectly assume that a relationship found at a higher level (e.g., organizational system usage positively affects organizational performance) exists in the same way at a lower level (e.g., individual system usage positively affects individual performance)" (Burton-Jones & Gallivan, 2007, p. 660).

- The atomistic fallacy poses a threat to external validity and occurs when researchers "incorrectly assume that a relationship found at a lower level (e.g., individual system usage positively affects individual performance) exists in the same way at a higher level (e.g., organizational system usage positively affects organizational performance)" (Burton-Jones & Gallivan, 2007, p. 660).

Both ecological and atomistic fallacies are captured in what Rousseau (1985) calls misspecification, which occurs when researchers "attribute an observed relationship to a level other than the actual

behavior and responsive unit" (p. 5). This often happens when researchers use the same construct to represent phenomena at different levels of analysis (Rousseau, 1985) without adequately testing this assumption. While aggregated perceptions about system variables can be used, they must be tested for the appropriateness of aggregation. Simply aggregating them does not necessarily mean that they are isomorphic with the actual higher order construct. For example, when measuring the down-time per month of a critical email server, the actual number of minutes of downtime can be captured from system reports as one single metric. However, asking 40 end users to recall the amount of downtime that occurred in the previous month will, undoubtedly, produce a wide range of responses. It is not the case that such variability is undesirable; rather, such perceptions might be the more important measure. However, there is a burden of proof on the researcher that perceptions should be aggregated at the entity level if such a measure is used at the higher level of analysis.

5.3. Phase 4: Theory Selection

An important phase of the research process is selecting appropriate theoretical foundations. This is what some researchers refer to as the theoretical perspective of multilevel research. For example, from a theoretical viewpoint, Bamberger (2008) discusses how researchers need to go beyond providing context for research findings to developing context theories. In doing so, he discusses how context theories can be used to narrow the gap between micro and macro perspectives in management research.

In our analysis of multilevel research, we found that IS researchers did a good job of selecting theoretical bases for their studies (18 out of 24 quantitative studies clearly stated their theories), and used a wide range of theoretical foundations. There were, however, few studies making use of multilevel frameworks or even multiple single-level theories each addressing a given level or entity. In fact, only two studies in our sample purposely use existing multilevel specific theories (although a few build multilevel models). The first is a conceptual paper describing the state of research on culture in IS (Leidner & Kayworth, 2006). The authors use Schein's (1984) three-level model of culture framework. The second is a study of IT compensation (Levina & Xin, 2007), which makes use of a multilevel framework of IT compensation structures developed by Ang, Sandra, and Ng (2002).

Why do only a small number of studies use multilevel frameworks? One possible reason is that there are few multilevel frameworks available. There are, however, several possibilities for researchers interested in conducting multilevel research. First, some existing theories could be applied in multilevel environments. One of the best examples is adaptive structuration theory (AST). In developing AST, DeSanctis and Poole (1994) suggest that it could be a prime candidate for multilevel research. Several of the constructs in AST are at collective entity levels: task and organizational environment (organization), group's internal structure (group), new social structures (group or other collective); while other constructs of the theory are at the individual entity level: appropriation moves and faithfulness, decision processes, and decision outcomes. Depending on the theorizing the researchers make, AST allows multilevel concepts to be tested. In fact, AST is recognized as one of the more useful meta-theories for examining information systems in organizational settings (Bostrom, Gupta, & Thomas, 2009).

Clearly, not all researchers can use AST as a theoretical foundation for their work. Given that there are few multilevel theories available, researchers often need to develop their own theoretical framework. An example is Burton-Jones and Gallivan (2007), who focus on the development of a conceptual multilevel framework of IS usage (reproduced in Figure 3). The authors discuss at length the need for multilevel research on this topic and the issues that arise from not conducting this research using a multilevel perspective. We expect that future work will test the validity of their derived multilevel framework. In another example, Jasperson et al. (2005) propose a multilevel framework for post-adoptive IT use. Table 5 includes four additional examples of conceptual papers addressing multilevel concepts explicitly.

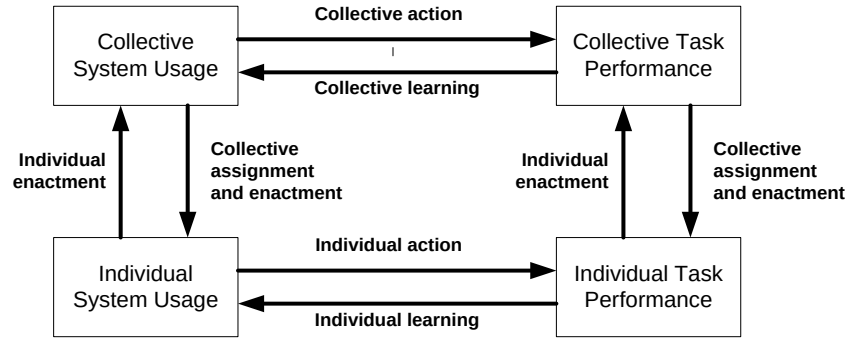

Figure 3. Theoretical Model of Systems Usage (Burton-Jones & Gallivan, 2007)

5.4. Phase 5: Research Design

Based on the research question, the entities and variables of interest, and an appropriate theoretical foundation, researchers can then articulate their research design. This includes deciding whether to conduct empirical research or develop a conceptual model, and whether to use qualitative or quantitative, inductive or deductive, interpretivist or positivist, cross-sectional or longitudinal approaches. In general, IS researchers discuss their research design in detail, which made identifying the research design straightforward in the review. Within our sample of quantitative studies, a large portion of the multilevel studies used a longitudinal research design (12 out of 24). It may be that longitudinal studies are needed to identify interactions of lower-level entities because they lead to the emergence of collectives; it may also be due to research questions lending themselves to process models. Of course, longitudinal research can serve other broader purposes too (Raudenbush & Bryk, 2002; Singer & Willett, 2003).

A surprising result of our targeted review was that only 33 percent of the quantitative multilevel studies explicitly state that they are multilevel (Table 4). Most of our conceptual papers (67%) do recognize multilevel issues explicitly (Table 5), possibly due to the need to first develop a multilevel framework in which to ground one's research (i.e., qualitative studies and conceptual papers may offer more explicit opportunities for theory development). It is important to be explicit about whether one is conducting multilevel research.

5.5. Phase 6: Multilevel Analytical Technique Selection

One of the most challenging tasks in multilevel research is analyzing data and reporting the findings. In the quantitative multilevel studies we reviewed (Table 4), a wide variety of analytical methods are used, but only three papers (Cummings et al., 2009; Levina & Xin, 2007; Rai et al., 2009) use a pre-existing, commercial multilevel statistical tool (in this case, HLM).

Tools used in a variety of other disciplines for analyzing multilevel data include Hierarchical Linear Modeling (HLM), DETECT, and R. Other tools that have recently become available include MLwiN (Rasbash et al., 2009) and MPlus (Muthen & Muthen, 2007). In addition, researchers now have several multilevel regression, SEM, and specialty tools to conduct analysis on micro and macro perspectives (Cheung & Au, 2005; Cheung, Leung, & Au, 2006) and new variants of these tools in which features of DETECT and OLS have been combined (Schriesheim, 1995). Multilevel analyses can also be conducted with SAS (Bickel, 2007) and SPSS using the MIXED procedure (Peugh & Enders, 2005), and cross-level analysis may be conducted using LIMDEP 8.0 (Levina & Xin, 2007). However, these tools may be difficult to use when one is not accustomed to using the multilevel features. For example, one of the studies in our sample attempted to test group level variables using structural equation modeling and partial least squares as primary multilevel analytical techniques, but they used individual data not grouped by teams in their analyses (Wakefield, Leidner, & Garrison, 2008). Yet, multilevel researchers clearly suggest that one cannot study multilevel phenomena

accurately using individual level data only without aggregating that data by group. As Heck (2006) notes, "where similarities among individuals due to groupings are present, multilevel models are acknowledged to provide more accurate assessments of the properties of groups than are single-level analyses" (Heck, 2006, p. 388).

Multilevel researchers must measure the construct of interest on at least two levels. Measurement at the micro level, especially when the micro-level unit of analysis is the individual, is not as challenging as measuring the construct at a macro or collective level. Often, individual-level data is aggregated to account for the high-level construct measurement. Aggregation across levels of analysis is one of the most discussed topics in the multilevel research arena (e.g., Dansereau & Dumas, 1977; James, 1982; Rousseau, 1985). Morgeson and Hofmann (1999) maintain that "measures of an individual-level construct cannot always be aggregated and assumed to be a veridical representation of its collective counterpart", and this point of view reflects a general agreement among multilevel researchers that one cannot simply aggregate measures without some type of justification. These authors recognize that it is the interaction between individuals that creates "jointly produced behavior patterns, which lie between the individuals involved" (p. 252). This does not mean that data cannot be collected from individuals to analyze collective constructs; however, uninformed and ubiquitous aggregation of individuals' data may not appropriately reflect the collective effect of a construct at the team, group, or organization level.

More specifically, it is in the pursuit of whole unit effects based on component data that the issue of aggregation arises. This issue translates into the question: how much convergence is required to qualify an entity as showing a whole unit effect? In answer to this question, the general logic is as follows:

a) there must be sufficient explained variance on variable X from an ANOVA perspective

b) there must be sufficient explained variance on variable Y from the same ANOVA perspective, and

c) the resulting entity-based averages ideally should also be correlated and significantly larger than the alternative within-entity correlations.

Not all multilevel studies have pursued all three inferences, and there is a great deal of debate about just how strong an effect must be to qualify as finding a whole entity effect (Bliese & Halverson, 1998; Yammarino & Markham, 1992). Yet, it is important to minimize the chances of drawing an incorrect conclusion that is due to a statistical artifact rather than a replicable finding. Streams of research may be impacted by this error. In fact, research on e-collaboration has reported inconsistent findings that may reflect the inappropriate analysis of individual-level data despite the application of group-level theory (Gallivan & Benbunan-Fich, 2005). Clearly, researchers must ensure that they use proper measurements at the entity level of interest.

6. Opportunities for Multilevel IS Research

With IT's ubiquity in contemporary organizations, IS researchers can play a major role in pushing the boundaries of multilevel research by exploring the inter-relationships of technology, people, and groups of people. The findings of our review of multilevel IS research suggest that IS researchers have not yet really begun to delve deeply into the multilevel IT paradigm. We offer here specific opportunities for multilevel IS research in the various IS themes identified in our sample of published IS studies that included some multilevel elements.

Our analysis of the sample of IS multilevel research by theme (Section 5.1) reveals several avenues for future research. For example, when considering initial IS use, IS researchers have long recognized that IT-adoption decisions are made at the organizational level, but also that the initial use decisions are often made at the individual level (Sambamurthy & Zmud, 2013). Multilevel work in this area might be best characterized as mono-compositional models of people nested in organizations in

a top-down structure (see Figure 2). However, studies of continued IS use are somewhat different. While the organization's actions may impact individual behaviors, individual behaviors are also likely to impact organizational action (Jasperson et al., 2005). While such studies may still take the form of mono-compositional models, they can be nested as either top-down or bottom-up, or potentially be conceptualized as bi-directional. Researchers studying such phenomenon may ask research questions such as: what individual continued IT use behaviors converge to impact organizational IT use, or how do they converge? For example, Nan (2011) incorporates a bottom-up process in the complex adaptive systems (CAS) model of IT use. The CAS model offers a means by which to consider the emergence of IT use at the collective level based on patterns of IT use behaviors exhibited at the individual level. In the CAS model, collective IT use patterns and outcomes emerge from individual actions and IT features that the individuals choose to use. As individuals exhibit common IT use patterns, the collective pattern of IT use emerges.

Alternatively, researchers could ask: how do organizational actions (e.g. training, mandated use, incentives) impact both initial and continued individual usage behaviors such that these behaviors converge into collective behavior? Alternatively, an investigation of feature-level adoption and initial use acknowledging that different feature-set usage may result in different perceptions or even definitions of the overall system could result in a either a mixed- or mono-compositional, within-entity study. Such studies could answer research questions such as: what feature-level use impacts overall system success?, or what feature-level use can be incorporated in organizational actions (e.g., training, mandated use, incentives) to positively impact later-stage system success? Such studies have the potential to not only impact this stream of academic research, but also offer interesting insight to IT practitioners involved in systems development, training, or project management[5]. Mixed-compositional studies would likely focus on which features are used, while mono-compositional studies might focus on how/why the features are used (i.e., behavior, habit, social norms, etc.).

In the topic area of collaboration, several potential questions can be identified around within- vs. between-group differences or behavior. Sarker and Valacich (2010) perhaps articulate this notion best when they argue that group-level phenomena may be investigated from an individual reductionist perspective wherein groups are viewed simply as ensembles of individuals; however, such investigations assume uniformity in individual members (i.e., the homology thesis). They found that the individual reductionist view failed to adequately predict group-level adoption phenomenon and cautioned researchers to use group-level measures that accommodate non-uniformity within groups. Interestingly, organizational researchers also suggest within-group differences may offer valuable insight. Harrison and Klein (2007) suggest that group diversity be considered in terms of separation, variety, or disparity. While these measures may be useful in studying between group effects of diversity, each also represents a measure of within-group variance. Further, group conflict researchers have recently turned their attention to conflict asymmetry rather than group-level conflict (Jehn, Rispens, & Thatcher, 2010). Conflict asymmetry is a disparity measure and the authors argue that it is not level of conflict per se that negatively impacts group outcomes so much as the variance in perceptions in the team. IS researchers interested in group-level phenomena may build on this past work and focus on multilevel questions such as: is it variety or disparity in relational variables (i.e., conflict, cohesion, trust) that impacts groups outcomes (i.e., performance, satisfaction) in virtual teams? This would be a clearly mono-compositional, within-entity model. Alternatively, Sarker and Valacich (2010) argue that group-level researchers need to acknowledge the "we-ness" of groups. In so doing, one must recognize that groups are not merely the aggregation of their parts. For IS researchers, an important question here is: what role does IT play in developing "we-ness?". Such a question could be addressed using a mixed-compositional model if the IT role was assessed based on what the collaborative technology does (i.e., its features). A recent study sought to explore similar issues by developing and testing a model of collaborative technology (CT) considering individual-level factors and the group and organizational context in which CT use occurred (Kan, Lim, Kim, & Yang, 2012). Again, investigating these questions is valuable from a purely academic perspective, but it also can offer insight to managers who are trying to build and sustain a globally distributed workforce.

[5] We would like to thank one of our excellent reviewers for this insight.

Research into IT and emotions is relatively new but represents an opportunity to think about collective behavior and the IT artifact. Studies of emotion and IT fall into two broad categories: emotional reactions to IT (see Zhang, 2013) and IT as a conduit for expressing emotion. Unexpected interaction with IT (i.e., either negative or positive gaps between what is expected and what is experienced during IT use) can elicit emotional responses from users and trigger computer-related thoughts Responses may be positive (i.e., "Wow, my Twitter post was read by 1,000 people!") or negative (i.e., "Yuck! The new system is hard to use"). Further, when such events are experienced by multiple users of a system, users may also share the emotional response. The development of such group-level shared emotion, it has been argued, is what defines a group and distinguishes it from a collection of individuals (Barsade, 2002). As such, emotional responses to or experiences with technology potentially represent event-driven collective emergence. How might such events manifest and, more importantly, be captured in academic research? Let us consider an example. Online communities are informal collectives organized through online communication and are used to coordinate actions and keep meaningful interactions through time (Hercheui, 2011). As online communities become more prevalent, research about this informal collective is increasingly of interest to researchers and practitioners. What is the role of technology (i.e., the "online" part)? Is it simply a facilitator useful for bringing like-minded people together, or is it the catalyst? Measuring the emotional response to the technology facilitating interaction versus the issue or task in which the community engages could detangle this.

Finally, in the knowledge management literature, multilevel investigations may help identify new entities. We introduce a discussion of the role of technology with examples from ERP, databases, websites, knowledge repositories, and online communities. Other entities that IS researchers might consider include data because data can be nested in people, such as memory or knowledge. In this case, the person provides the context in which memories (Wright, 1998) or knowledge elements emerge.

In the context of knowledge management research, the understanding of the person as a collective of knowledge (or knowledge accumulation) therefore offers a new lens to understand how individuals acquire, use, and share knowledge. Additional consideration of databases and websites may point to the objects themselves acting as the collective. Cultures may also be considered as collectives in this context. For example, Ravishankar, Pan, and Leidner (2011) recognize the impact of organizational cultures and subcultures on knowledge management systems. Although knowledge management systems are implemented at the organizational level, they incorporate the impact of subunit-levels.

To facilitate future identification and evaluation of multilevel research, we provide Appendix B, which includes a discussion of both intentionality—demonstrating how the research intends to be multilevel—and execution—actually performing multilevel research using appropriate conceptualization, theorizing, data collection and analysis, and drawing of appropriate inferences. Furthermore, while our analysis focused on quantitative studies, our finding that many studies of multilevel phenomena were qualitative indicates that qualitative researchers might be well positioned to inform quantitative researchers planning to perform multilevel research. This provides a great opportunity for future research by combining approaches.

We conclude this discussion of opportunities with one caution. By not explicitly identifying multilevel research as such, IS researchers may sell short the true contributions of their research and inhibit the progress of IS research as a field. For example, IS researchers conducting multilevel research contribute findings and present implications for multiple entities in one research project. However, if they do not identify their research as multilevel, the reader may interpret the findings with a single entity in mind and, therefore, miss the additional contributions of the paper to other levels or entities. Additionally, not explicitly labeling research as multilevel inhibits future researchers' ability to synthesize and build on completed multilevel IS research. If researchers do not use the terms associated with multilevel research (e.g., multilevel, cross-level), then keyword searches will not return an exhaustive list of multilevel research in the area of interest, and thereby hamper the progress of IS research. Therefore, there is a clear need to properly classify IS multilevel research so new studies use the full foundation of existing IS multilevel research. Failure to explicitly recognize the multilevel nature of one's research can also lead to flaws in the design of studies, which is evident where we discuss the findings regarding phases 2, 3, 5 and 6 of the review framework in Section 5.

With this paper, we hope to start a dialogue in the IS community about multilevel research. While our recommendations may be viewed as a recipe for conducting better multilevel research, it should not be viewed as the final word. We encourage ongoing development in this area.

7. Conclusions

Many IS phenomena are complex and multilevel in nature. However, most IS researchers are studying these phenomena without explicit recognizing their nature. This could be the result of many factors. First, there may be a lack of understanding in the field about what multilevel research is and how it should be conducted. Second, few multilevel theories exist to guide such research. Nevertheless, some researchers are beginning to develop such models. With new models and methods of analysis becoming available to conduct multilevel research, the IS field should see a growth in research conducted via this lens. A third potential reason for a scarcity of multilevel research in IS is the lack of common terminology regarding multilevel phenomena that may be inhibiting researchers' awareness of potential multilevel research opportunities. Thus, a common language with which to refer to multilevel phenomena may encourage active discussion and consideration of potential multilevel research topics.

This paper focuses on raising awareness about the multilevel phenomenon in IS research by distinguishing between explicitly stated and implicitly conducted multilevel research in IS and discussing the related issues and consequences. We also provide tools to identify the multilevel nature of IS papers and guidelines for the development and evaluation of multilevel IS research. Finally, we present the unique role of the IT entity in developing multilevel opportunities for IS researchers and offer research questions to that effect. Our intention in presenting these questions is not to propose a detailed research plan, but rather to demonstrate to IS researchers that legitimate and recognized topics in IS can benefit from a multilevel approach.

Conducting multilevel research is not easy. It requires more planning because researchers must not only consider measurement issues and implications of findings for one entity, but for many. Even with these difficulties, we believe it is important for IS researchers to consider the multilevel nature of their work. This is not to say that everyone should be conducting multilevel research, or that there is no value in single level research findings. On the contrary, under clearly specified boundary conditions, traditional approaches can and should continue to be used. Nevertheless, as the IS field matures, it faces the challenge of simultaneously providing greater insights to practitioners and researchers on the IS phenomena of interest. Much like other business research fields, moving to multilevel frameworks is a desirable evolution. In fact, we believe that multilevel research offers the potential for providing a better understanding of the very core of our field by examining IT entities and people and their interactions.

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Appendices

Appendix A. Literature Review Details

To explore issues surrounding multilevel research in the IS literature, we collected every paper published in two leading IS journals between 2002 and 2010: *Information Systems Research* and *MIS Quarterly*. The sampling frame consisted of 526 paper. Because we wanted to identify not only explicitly stated multilevel research but also implicitly conducted multilevel research papers, we conducted several rounds of coding, which Figure A-1 describes. As a result of the coding process, we identified 51 multilevel papers.

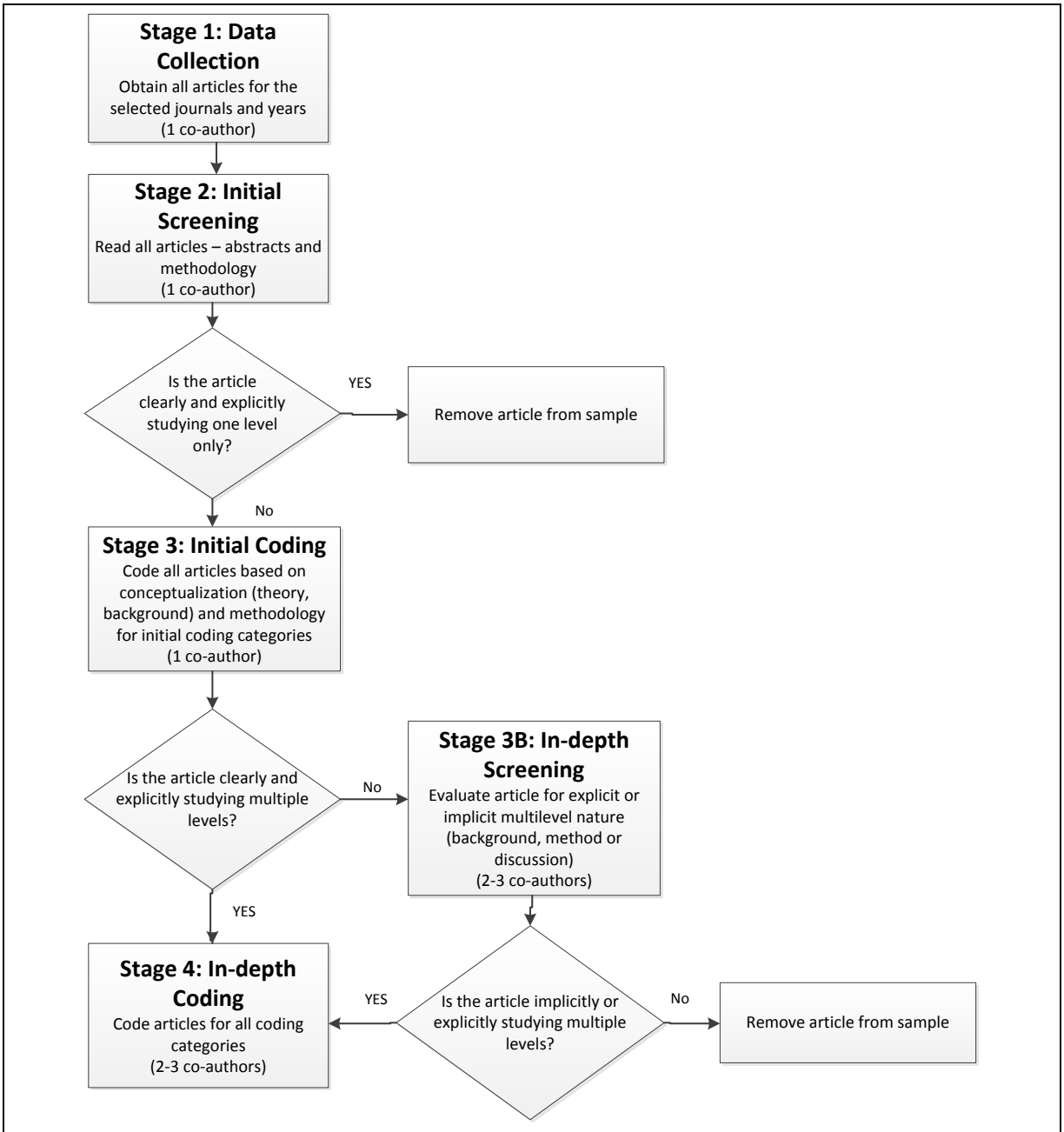

Figure A-1. Coding Process for Literature Review

In coding papers for explicitly stated versus implicitly conducted studies, we identified papers that used keywords such as multi-level, multilevel, cross-level, cross level, dyadic, collective, macro or micro in their title, abstract or keywords, or that described clearly their unit or level of analysis as being at multiple levels. We developed a coding template to identify key elements of each paper retained after phase 1 (initial screening; marked with * in Table A-1). We revised this template several times to add additional coding elements as we moved through phases 2 and 3 of the coding. Table A-1 presents the main coding categories used in the initial and in-depth coding stages. A minimum of two (but often three) researchers then jointly coded the remaining 51 papers; we discussed disagreements until we agreed.

Table A-1. Coding Categories and Definitions

Coding category*	Definition
Levels of analysis*	Individual, group, project, intra-organizational, organizational, inter-organizational, societal—select all that apply.
Sample size*	Describe size of sample (same level as answer to previous question).
Sample nature*	Describe nature of sample (students, business organizations, etc.).
Research approach*	Quantitative, qualitative, mixed methods, conceptual.
Study type*	Case study, field experiment, field study/survey research, lab experiment, meta-analysis, network analysis, simulation, other—select all that apply.
Length of study*	Cross sectional, longitudinal, other.
Area of application*	Describe the major research question.
Type of technology	If there is a focus on technology, what type?
Theoretical basis	Theory used or major previous literature upon which the study builds.
Nature of exploration	hypotheses testing, propositions developed, research questions explored, framework development, not evident—select all that apply.
Independent variables	Independent variables used by the authors in their paper.
Dependent variables	Dependent variables in study.
Other variables	Other constructs of interest.
Multilevel viewpoint	How do authors describe the multilevel nature of the study (clearly articulated multilevel analysis, reason? Multilevel citations?) .
Collective level analysis	Data analysis tool or approach used at the collective level.
Findings	Major deliverables, findings, lessons, etc.

Notes: * denotes categories used in initial and in-depth coding phases.

Appendix B: Guidelines for Conducting and Evaluating Multilevel IS Research

While our paper provides general guidelines for conducting multilevel research, we provide in this appendix a succinct summary of steps IS researchers can take to either develop their own multilevel research and/or evaluate other research regarding multilevel concepts.

First, we suggest that IS researchers clearly indicate their intentions to conduct multilevel research throughout their writing. As a result, they will clearly state the multilevel nature of their research, theory, and design so as to capture data at the appropriate entity level. Figure B-1 shows the areas that an IS researcher needs to consider when demonstrating the intent to conduct multilevel research in an ideal situation.

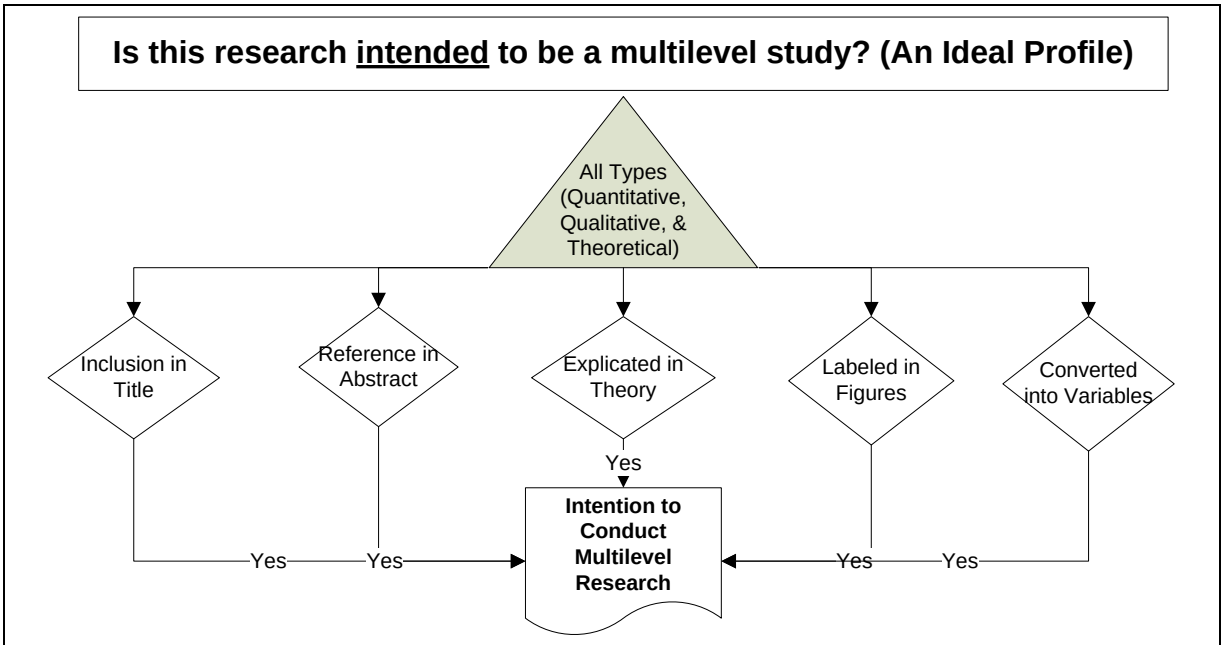

Figure B-1. Guidelines for Intentionality of Multilevel IS Research

The importance of demonstrating intentionality is underscored by the findings of our literature review where a large proportion of the multilevel papers do not explicitly recognize the nature of their work, which can lead to the fallacies discussed in our paper. Figure B-2 summarizes the issues we faced when trying to classify the papers as multilevel. Some papers were not explicitly developed to conduct multilevel research but, in their execution of the research, they actually did. Others articulated a multilevel research approach, but failed to properly execute the research design. All of these are problematic for all of the reasons discussed in the paper. For reviewers, the figure can be useful in determining the nature of the work presented to them.

Execution	Intentionality: Implicit	Intentionality: Explicit
Simple	Q1: These are simple studies in which the level of analysis issue is assumed, and, therefore, not subject to any hypothesizing or testing. While the study might hint or suggest multilevel issues in the introduction, there is no intent to test or pursue them.	Q2: These are misnomer studies in that the introduction clearly sets the expectation that both variables and entities are to be tested, but, in the execution, the study resembles a simple study as in Q1. Alternatively, the study's theory might be formulated as multilevel, and data collected from two different types of entities, but no test is made of the entity effect.
Intricate Levels	Q3: These are unintentional studies in which the title and introduction do not explicitly focus on issues of testing entities, but the execution of the study includes entity testing as well as variable testing.	Q4: These are unambiguous studies in which both the intent and the delivery conform to expectation for testing entities as well as variables. While there might be debate over how well either aspect was accomplished, there is little question about the categorization.

Figure B-2. Intentionality vs. Execution of Multilevel Research

Second, IS researchers need to consider the theory applicable to their research and whether the theory is a multilevel theory or if it may be extended to include a multilevel perspective. If the theory is not multilevel, then IS researchers need to develop their own or extend existing theories' multilevel concepts. In either case, this becomes an exercise in theory development. Below are some questions that may be useful in identifying whether or not the theory is multilevel:

1) Does the research or theory directly mention multilevel in the title, abstract or explanation of the theory?

2) Do the figures used to depict variables present multilevel entities of interest?

3) If the theory does not explicitly consider constructs from a multilevel perspective, can a theoretical model based on existing concepts be developed and/or extended to consider these multilevel constructs?

One approach to the development or extension of prior theory to a multilevel framework has been proposed by Burton-Jones and Gallivan (2007). In a simplified version of that work, we generalize broad steps that may allow IS researchers to develop their own multilevel frameworks in Table B-1.

Table B-1. Key Elements in the Development of a Multilevel Research Framework

Conceptualization	Description	How to theorize for multilevel research?
Function	What the construct is meant to do in this theoretical framework. In other words, it represents the effects or outputs of a phenomenon the construct represents.	Evaluate the function of the construct at different levels. If the construct manifests similar relationships at a different level than the level it was originally conceptualized at, it can be conceived at this other level. In most cases, the constructs are conceptualized at the individual level and need to be evaluated for appropriateness of relationships at the collective level.
Structure	What relationships and actions are needed for the construct to emerge?	To develop a multilevel research framework, researchers need to examine which structures are needed for the construct at the different levels for the construct to emerge. If no structure can be identified for a construct at a collective level, it may be that the construct cannot be conceptualized at that level.
Interdependencies	How is the construct related to others at a different level?	Researchers need to conceptualize how the interdependencies in the individual level phenomena give rise to the collective level constructs or phenomena. This involves exploring not only what but also why interactions at lower-level phenomena may lead to a collective concept. For example, explaining why increased coordination and communication between individuals in dyads may lead to a cohesive team at the group level.
Form	The form the collective construct takes.	For collective constructs, researchers must identify its expected form, which can be one of three: global, shared, or configural. In simplified terms, a global form exists when the construct is theorized at the collective level (team cohesion exists at the team level and is not derived from individual level constructs); a shared form exists when the collective construct emerges from the attributes of individual level constructs in an homogeneous form (individuals converging on the same features of a new information technology to effect change at the group level (see Leonardi (forthcoming)); a configural form also results from emergence from the attributes of individual level constructs but in a form that is heterogeneous (team expertise emerges from the collective expertise of individuals but they have different levels of expertise).
Context	What factors within the boundaries of the theoretical framework affect the construct of interest?	As in all theorizing, it is important for researchers to identify contextual factors that may affect the constructs at the various levels, as well as their interactions with other constructs and across levels.

Third, research questions and/or hypotheses must reflect the multilevel nature of the work, typically with constructs at the individual and collective levels (although constructs could be at two collective levels).

Finally, the multilevel nature of the constructs in the research questions and hypotheses will guide the research design. For example, a longitudinal research approach may be necessary to test constructs

measured at the collective level because of the time required for the collective to emerge. Figure B-3 summarizes the guidelines for executing multilevel research.

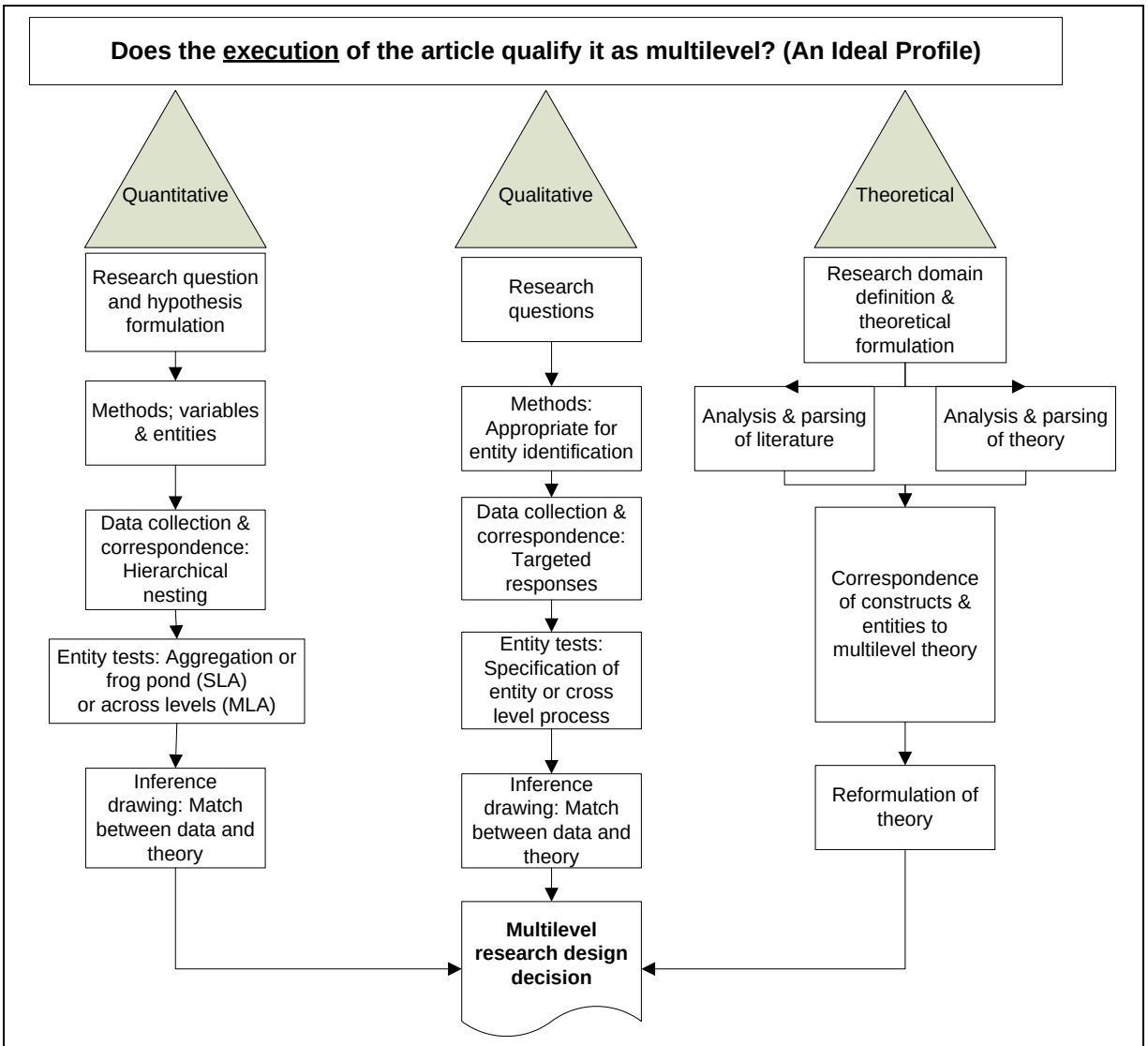

Figure B-3. Guidelines for Executing a Multilevel Research Project