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Qualitative Research Methods for Evaluating Computer Information Systems

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Introduction

Qualitative research methods are being used increasingly in evaluation studies, including evaluations of computer systems and information technology. This chapter provides an overview of the nature and appropriate uses of qualitative methods and of key considerations in conducting qualitative research.

The goal of qualitative research is understanding issues or particular situations by investigating the perspectives and behavior of the people in these situations and the context within which they act. To accomplish this, qualitative research is conducted in natural settings and uses data in the form of words rather than numbers. Qualitative data are gathered primarily from observations, interviews, and documents, and are analyzed by a variety of systematic techniques. This approach is useful in understanding causal processes, and in facilitating action based on the research results.

Qualitative methods are primarily inductive. Hypotheses are developed during the study so as to take into account what is being learned about the setting and the people in it. Qualitative methods may be combined with quantitative methods in conducting a study. Validity threats are addressed primarily during data collection and analysis.

The chapter discusses these points and uses an evaluation of a clinical laboratory information system to illustrate them.

Computer information systems can significantly improve patient care, hospital management and administration, research, and health and medical education. However, many systems do not achieve these goals. Dowling estimated that 45% of computer-based medical information systems failed due to user resistance, even though these systems were sound technologically. Thus, the stakes in developing, implementing, and evaluating such systems are high [1].

Different evaluation objectives require different methodological approaches. Many evaluations of medical computer information systems focus on impacts such as costs and benefits, timeliness, completeness, error

rates, retrievability, usage rates, user satisfaction, and clinician behavior changes [2,3]. Quantitative methods are excellent for studying these kinds of evaluation questions, in which selected features of the information technology, the organization, the user, and the information needs generally are treated as independent, objective, and discrete entities, and as unchanging over the course of the study [4].

When a researcher or evaluator wishes to study issues that are not easily partitioned into discrete entities, or to examine the dynamics of a process rather than its static characteristics, qualitative methods are more useful than solely quantitative ones. The strengths of qualitative research methods lie in their usefulness for understanding the meaning and context of the phenomena studied, and the particular events and processes that make up these phenomena over time, in real-life, natural settings [5]. When evaluating computer information systems, these contextual issues include social, cultural, organizational, and political concerns surrounding an information technology; the processes of information systems development, installation, and use (or lack of use); and how all these are conceptualized and perceived by the participants in the setting where the study is being conducted [6]. Thus, qualitative methods are particularly helpful for any of the following:

- To determine what might be important to measure, why measured results are as they are, or if the subject of study cannot be measured easily
- To understand not only what happened, or what people are responding to, but why; to understand how people think or feel about something and why they think that way, what their perspectives and situations are and how those influence what is happening; to understand and explore what a technology (such as an newborn nursery telemonitoring system) or practice (such as using a computer to access health information) means to people
- To investigate the influence of social, organizational, and cultural context on the area of study, and vice versa
- To examine causal processes, and not simply what causal relationships exist
- To study processes as they develop and emerge, rather than in outcomes or impacts; for example, to investigate the development process for the application under study in parallel with that process so that you can improve the application development as it progresses.

Qualitative research methods have undergone significant development in recent years [7–10] and are being increasingly used in evaluation research both within and outside health care [6,10–13]. There also is a growing literature on combining qualitative and quantitative methods [14–22]. The purpose of this chapter is to explain what qualitative approaches can contribute to medical computer systems evaluations. We begin by describing the nature and goals of qualitative research and evaluation, and illustrate these with an example of the use of qualitative methods in computer

information systems evaluation. We then discuss some key considerations in qualitative evaluation research and present the most important methods used in this approach.

The Nature of Qualitative Research

"Qualitative research" refers to a range of approaches that differ significantly among themselves, but that share some defining characteristics and purposes. These approaches are known by a variety of terms, some broad and some quite specific. The more general terms, which are more or less equivalent to "qualitative research," are "field research" and "naturalistic research." More specific terms, denoting particular types of qualitative research, are "interpretive research," "ethnographic research," "phenomenological research," "hermeneutic research," "humanistic research," and some kinds of case studies or action research [23]. We use "qualitative research" to refer to all of these.

Qualitative research typically involves systematic and detailed study of individuals in natural settings, instead of in settings contrived by the researcher, often using open-ended interviews intended to elicit detailed, in-depth accounts of the interviewee's experiences and perspectives on specific issues, situations, or events. Qualitative methods employ data in the form of words: transcripts of open-ended interviews, written observational descriptions of activities and conversations, and documents and other artifacts of people's actions. Such data are analyzed in ways that retain their inherent textual nature. This is because the goals of qualitative research typically involve understanding a phenomenon from the points of view of the participants, and in its particular social and institutional context. These goals largely are lost when textual data are quantified and aggregated [5].

Reasons for Qualitative Research

There five main reasons for using qualitative methods in evaluating computer information systems:

1. Understanding how a system's users perceive and evaluate that system and what meanings the system has for them

Users' perspectives generally are not known in advance. It is difficult to ascertain or understand these through purely quantitative approaches. By allowing researchers to investigate users' perspectives in depth, qualitative methods can contribute to the explanation of users' behavior with respect to the system, and thus to the system's successes and failures and even of what is considered a "success" or "failure" [6].

2. Understanding the influence of social and organizational context on systems use

Computer information systems do not exist in a vacuum; their implementation, use, and success or failure occur in a social and organizational context that shapes what happens when that system is introduced. Some researchers consider this so important as to treat "context" as intrinsically part of the object of study rather than as external to the information system. Because of "context," in important respects, a system is not the same system when it is introduced into different settings [24,25]. As is true for users' perspectives, the researcher usually does not know in advance what all the important contextual influences are. Qualitative methods are useful for discovering and understanding these influences, and also for developing testable hypotheses and theories.

3. Investigating causal processes

Although experimental interventions can demonstrate *that* causal relationships exist, they are less useful in showing *how* causal processes work [26–28]. Qualitative methods often allow the researcher to get inside the black box of experimental and survey designs and to discover the actual processes involved in producing the results of such studies. Qualitative research is particularly useful for developing explanations of the actual events and processes that led to specific outcomes [7], or when causality is multidirectional and there is no clear effect or impact of one factor on some specific outcome [6]. In this way, qualitative methods can yield theories and explanations of how and why processes, events, and outcomes occur [29].

4. Providing formative evaluation that is aimed at improving a program under development, rather than assessing an existing one

Although quantitative and experimental designs often are valuable in assessing outcomes, they are less helpful in giving those responsible for systems design and implementation timely feedback on their actions. Qualitative evaluation can help both in system design as well as in studies of system use [6]. Using qualitative methods can help in identifying potential problems as they are forming, thereby providing opportunities to improve the system as it develops. These evaluations also allow for varying and changing project definitions and how the system and organization are mutually transformative, thereby enabling learning by monitoring the many experiments that naturally occur spontaneously as part of the processes of implementation and use [6].

5. Increasing the utilization of evaluation results

Administrators, policy makers, systems designers, and practitioners often find purely quantitative studies of little use because these studies do not seem related to their own understanding of the situation and the problems they

are encountering. Qualitative methods, by providing evaluation findings that connect more directly with these individuals' perspectives, can increase the credibility and usefulness of evaluations for such decision makers [10].

An Example: Evaluating a Clinical Laboratory Computer Information System

These attributes of qualitative research are illustrated by a study of a clinical laboratory computer information system used by different laboratories within one department of an academic medical center [16,30–32]. This system was evaluated by combining both quantitative and qualitative methods. A survey questionnaire was designed to assess the impact of the computer system on work in the laboratories. Qualitative data gathered from interviews, observations, and open-ended questionnaire questions were used to determine what changes were attributed to the computer system. Statistical analysis of the survey data initially revealed no differences among laboratory technologists' responses. Qualitative data analysis of their answers to open-ended questions indicated that laboratory technologists within each laboratory differed in their reactions to the system, as did laboratories as a whole. Some focused on work increases, whereas others emphasized improved laboratory results reporting and service.

Although the quantitative survey data provided no apparent reason for these differences, the qualitative data did, leading to further investigation. This investigation revealed that different technologists had different views of their jobs, and these different views affected their attitudes toward the computer system. For some technologists, the system enhanced their jobs, while for others, it interfered with their jobs, even though they ostensibly had the same jobs and were using the same system. Neither the researchers nor the laboratory personnel expected this finding, though the finding rang true. Further analysis of the quantitative data supported this explanation for the differences among laboratories and among technologists. In the original quantitative analysis, few differences were discernible among technologists or among laboratories from the quantitative data because standard quantitative measures of job characteristics assumed a uniformity of job situations and perceptions. However, this uniformity did not exist, as revealed in qualitative data that identified technologists' own views of their jobs and of the system.

This example illustrates several features of qualitative research. First, it was not possible to design, in advance, a quantitative study that would have tested the right hypotheses, because appropriate hypotheses could not be known in advance. A qualitative approach enabled the researchers to see how individuals construed the information technology, their jobs, and the interaction between the laboratory computer information system and their jobs. Thus, the researchers were able to generate productive hypotheses and theory.

Second, the qualitative data enabled the researchers to make sense of their quantitative findings. The qualitative data helped to explain why the quantitative results were as they were. This is one example of the point made above—that qualitative research often can uncover the causal processes that explain quantitative results.

Third, the qualitative data were able to serve these purposes because they helped the researchers understand the system from the points of view of those involved with it. These points of view are crucial to studying issues such as computer systems acceptance or rejection, or the changes that occur when a new system is introduced.

Fourth, a variety of human, contextual, and cultural factors affect system acceptance in actual use. Qualitative data enabled the researchers to understand the contexts in which the system was developed, installed, and used, and thus to understand differences among laboratories.

Finally, the results had face validity. They were believable to the laboratory director in the hospital where the study was done, to laboratory personnel in other hospitals, and even outside of hospitals where workers showed characteristics similar to the laboratory technologists'. Because the results were credible and the description of the laboratory technologists were recognizable, they were useful for others. This is the primary means by which qualitative studies can be generalized or results made transferable: not by statistical inference to some defined population, but through the development of a theory that has applicability beyond the setting studied [33], as was done in this study [16].

In the remainder of this chapter, we discuss some important considerations in designing and conducting evaluations that use qualitative methods.

Getting Started

The most important initial question for an evaluator is whether qualitative methods are appropriate for conducting the study. For this, it is important to consider what qualitative methods can add to an evaluation: what kinds of questions they are capable of answering, and what value they have.

Research Questions and Evaluation Goals

Qualitative methods typically are used to understand the perception of an information system by its users, the context within which the system is implemented or developed, and the processes by which changes occur or outcomes are generated. They usually focus on the description, interpretation, and explanation of events, situations, processes, and outcomes, rather than the correlation of variables, and tend to be used for understanding a particular case or for comparison of a small number of cases, rather than for generalization to a specified population. They are useful for systematically collecting so-called "anecdotal" evidence and turning the experiences they describe into data that can be rigorously collected and analyzed.

Thus, the questions posed in a qualitative study are initially framed as "what," "how," and "why" queries, rather than as whether a particular hypothesis is true or false. The fundamental question is "What is going on here?" This question is progressively narrowed, focused, and made more detailed as the evaluation proceeds. Qualitative studies may begin with specific concerns or even suppositions about what is going on, but major strengths of qualitative methods are avoiding tunnel vision, seeing the unexpected, disconfirming one's assumptions, and discovering new ways of making sense of what is going on. Qualitative evaluators typically begin with questions such as:

- What is happening here?
- Why is it happening?
- How has it come to happen in this particular way?
- What do the people involved think is happening?
- How are these people responding to what is happening?
- Why are these people responding that way?

To answer these questions, qualitative evaluators attempt to understand the way others construe, conceptualize, and make sense of what is happening in a particular situation. In doing this, they must become familiar with the everyday behaviors, habits, work routines, and attitudes of the people involved as these people go about their daily business. It also is important for evaluators to become familiar with the language or specialized jargon used by people involved with the study. Knowledge of behaviors, habits, routines, attitudes, and language provides a way of identifying key concepts and values. This knowledge enables the evaluator not only to better understand what is going on, but also to present findings in terms meaningful to the participants. Policy makers, department administrators, systems designers, and others will be able to recognize the situations being reported and, therefore, know better how to address them. In addition, individuals outside the organization where the evaluation is conducted will have sufficient context to develop a good understanding of it.

Further, qualitative methods can be used throughout the entire systems development and implementation process. They treat a computer information system project as a process, rather than as an object or event. By doing this, the evaluator can play an active role in the project, offering evaluations as the project progresses (formative evaluations) instead of having to wait until the project is completed (summative evaluations). In this way, evaluators can serve as a bridge between the interests of systems developers and systems users [6].

Recognizing diversity of perceptions also is important; "various individuals . . . may perceive it [an innovation] in light of many possible sets of values" [34]. For example, in Lundsgaarde and colleague's [35,36] evaluation of PROMIS, individuals who thought their professional status was enhanced by the system were more positive than those who felt their status

was lowered. Other values also can play a role; Hirschheim and Klein [37] illustrate this for systems developers, Kaplan [38–40] for the physician and developer values in systems development and use, while Sicotte and colleagues discuss a system failure in terms that contrast differences in values and goals among nurses and system developers [41,42]. A major strength of qualitative approaches is their sensitivity to this diversity and to unique events and outcomes.

Role of Theory

Theory is useful for guiding a study. Familiarity with the subject of study or with a wide range of theories and situations, for example, can help the researcher make sense of occurrences in the particular study being conducted. It can help the evaluator to not overlook important issues and help provide a set of constructs to be investigated. In this way, theory can shape research questions and focus. Theory also will guide a researcher's interpretation and focus. Theories of knowledge and epistemologies underlying research approaches influence how the project is conceived, how the research is carried out, and how it is reported. For example, Kaplan describes how three different theoretical perspectives would lead to different interpretations of Lundsgaarde, Fischer, and Steele's findings in their evaluation of PROMIS [43].

Theory may play different roles in qualitative research. Two different approaches may be taken, or combined. In the first, the evaluator works within an explicit theoretical frame. For example, postmodern and constructivist theories are becoming increasingly popular in studies of information systems [6,44]. In the second approach, the evaluator attempts to avoid prior commitment to theoretical constructs or to hypotheses formulated before gathering any data. Nevertheless, in each approach, qualitative researchers develop categories and hypotheses from the data. The two approaches may be combined. For example, an evaluator may start with research questions and constructs based on theory, but instead of being limited to or constrained by prior theory, also attempts to develop theory, hypotheses, and categories through using a strategy known as "grounded theory" [45,46].

Regardless of which approach is used, an evaluator cannot avoid a prior theoretical orientation that affects research and evaluation questions, as well as affecting the methods chosen for investigating those questions. The difference between the two approaches is not whether the evaluator has some prior theoretical bent—that is unavoidable—but whether the evaluator deliberately works within it or tries to work outside it.

Gaining Entry

An evaluation begins with the process of the researcher gaining access to the setting and being granted permission to conduct the evaluation. How

this is done shapes the researcher's relationship with the participants in the study, and, consequently, affects the nature of the entire study [12,18]. Some of these effects bear on validity issues, as discussed below. In addition to practical and scientific issues, negotiating a research or evaluation study raises ethical ones [6,10,47]. To help address some of the ethical concerns, we believe that, to the extent possible, all participants in the setting being evaluated should be brought into the negotiation process. Furthermore, doing interviews or observations may intrude into people's private lives, work spaces, and homes, and probe their feelings and thoughts. Personal issues may easily arise, so the researcher needs sensitivity to respect people's privacy and sensibilities. Often confidentiality is promised, which may require significant steps to protect people's identities.

Qualitative Research Design

Qualitative research primarily is inductive in its procedures. Qualitative researchers assume that they do not know enough about the perspectives and situations of participants in the setting studied to be able to formulate meaningful hypotheses in advance, and instead develop and test hypotheses during the process of data collection and analysis. For the same reasons, qualitative evaluations tend to be in-depth case studies of particular systems.

Qualitative research design involves considerable flexibility [5,7], for two reasons. First, many aspects of the project change over time, including the processes being studied, evaluation goals, definitions of "success," and who the stakeholders may be [6]. As they change, the study itself also may need changing. Second, qualitative inquiry is inductive and often iterative in that the evaluator may go through repeated cycles of data collection and analysis to generate hypotheses inductively from the data. These hypotheses, in turn, need to be tested by further data collection and analysis. The researcher starts with a broad research question, such as "What effects will information systems engendered by reforms in the UK's National Health Service have on relative power and status among clinical and administrative staff in a teaching hospital?" [48]. The researcher narrows the study by continually posing increasingly specific questions and attempting to answer them through data already collected and through new data collected for that purpose. These questions cannot all be anticipated in advance. As the evaluator starts to see patterns, or discovers behavior that seems difficult to understand, new questions arise. The process is one of generating hypotheses and explanations from the data, testing them, and modifying them accordingly. New hypotheses may require new data, and, consequently, potential changes in the research design.

Data Collection

The most important principle of qualitative data collection is that everything is potential data. The evaluator does not rigidly restrict the scope of

data collection in advance, nor use formal rules to decide that some data are inadmissible or irrelevant. However, this approach creates two potential problems: validity and data overload.

Validity issues are addressed below. The problem of data overload is in some ways more intractable. The evaluator must continually make decisions about what data are relevant and may change these decisions over the course of the project. The evaluator must work to focus the data collection process, but not to focus it so narrowly as to miss or ignore data that would contribute important insights or evidence.

Qualitative evaluators use three main sources for data: (1) observation, (2) open-ended interviews and survey questions, and (3) documents and texts. Qualitative studies generally collect data by using several of these methods to give a wider range of coverage [49]. Data collection almost always involves the researcher's direct engagement in the setting studied, what often is called "fieldwork." Thus, the researcher is the instrument for collecting and analyzing data; the researcher's impressions, observations, thoughts, and ideas also are data sources. The researcher incorporates these when recording qualitative data in detailed, often verbatim form as field notes or interview transcripts. Such detail is essential for the types of analysis that are used in qualitative research. We discuss each of these data sources in turn, drawing again on Kaplan and Duchon's study and several other studies for examples.

Observation

Observation in qualitative studies typically involves the observer's active involvement in the setting studied; it is usually called "participant observation" to distinguish it from passive or non-interactive observation. Participant observation allows the observer to ask questions for clarification of what is taking place and to engage in informal discussion with system users, as well as to record ongoing activities and descriptions of the setting. It produces detailed descriptive accounts of what was going on (including verbal interaction), as well as eliciting the system users' own explanations, evaluations, and perspectives in the immediate context of use, rather than retrospectively. Such observation often is crucial to the assessment of a system. For example, Kaplan and Duchon went to the laboratories to observe what technologists actually did, rather than simply depend on verbal reports or job descriptions; Forsythe [50,51], in her studies of physicians' information needs, attended hospital rounds and recorded each request for information.

Observation also can be conducted when evaluating the potential uses of a proposed computer information system. Kaplan, for example, observed how the flowsheets in the patient record were used in an intensive care unit when it was suggested that flowsheets be replaced by a computer terminal that would display laboratory data in graphic form. She observed that only the pharmacist consulted the flowsheets. When a physician came to see the patient, or a new nurse came on duty, he or she assessed the patient's con-

dition by talking to the nurse who had been caring for that patient, rather than by consulting the patient's record. These observations raised a number of issues that would need addressing if a computer display of flowsheet information were to be implemented successfully. In another study preparatory to developing a system to make clinical images part of an online patient record, physician use of images was studied [52].

Open-Ended Interviews and Survey Questions

Open-ended interviewing requires a skillful and systematic approach to questioning participants. This can range from informal and conversational interviews to ones with a specific agenda. There are two distinctive feature of open-ended interviewing. First, the goal is to elicit the respondent's views and experiences in his or her own terms, rather than to collect data that are simply a choice among preestablished response categories. Second, the interviewer is not bound to a rigid interview format or set of questions, but should elaborate on what is being asked if a question is not understood, follow up on unanticipated and potentially valuable information with additional questions, and probe for further explanation.

For example, Kaplan and Duchon interviewed laboratory directors and chief supervisory personnel to determine what they expected the potential effects of the computer system would be on patient care, laboratory operations, and hospital operations. They asked such questions as "What effects do you expect the computer system to have?" so as not to constrain what the interviewees would answer. They also asked "What do you think this study should focus on?" so as to explore issues they had not anticipated.

A close analogue to open-ended interviewing, for large groups of respondents, is using open-ended survey questions. Kaplan and Duchon included in their survey such open-ended questions as "What important changes do you think the computer system has caused?" The final question on the survey was a request for any additional comments. Such questions are important to include in interviews and questionnaires to insure that unanticipated issues are explored.

Another way to investigate the views of groups of respondents is through focus groups. This involves interviewing several people together, and adds an opportunity for those present to react and respond to each others' remarks [53,54].

Documents and Texts

Documents, texts, pictures or photographs, and artifacts also can be valuable sources of qualitative data. For example, Nyce and Graves [55] analyzed published texts, case memoirs, and novels written by physicians in their study of the implications of knowledge construction in developing visualization systems in neurology. In Kaplan's studies of the acceptance and diffusion of medical information systems [38–40,56], she did close read-

ings of original source documents: published research papers; popularizations in medical magazines, newsletters, and books; conference reports; memoirs of individuals who developed the systems; and books commissioned by federal agencies.

Data Analysis

The basic goal of qualitative data analysis is understanding: the search for coherence and order. The purpose of data analysis is to develop an understanding or interpretation that answers the basic question of what is going on here. This is done through an iterative process that starts by developing an initial understanding of the setting and perspectives of the people being studied. That understanding then is tested and modified through cycles of additional data collection and analysis until an adequately coherent interpretation is reached [7,10].

Thus, in qualitative research, data analysis is an ongoing activity that should start as soon as the project begins and continue through the entire course of the research [5]. The processes of data collection, data analysis, interpretation, and even research design are intertwined and depend on each other.

As with data collection, data analysis methods usually cannot be precisely specified in advance. As noted previously, qualitative data collection and analysis have an inductive, cyclic character. As Agar describes it:

> You learn something ("collect some data"), then you try to make sense out of it ("analysis"), then you go back and see if the interpretation makes sense in light of new experience ("collect more data"), then you refine your interpretation ("more analysis"), and so on. The process is dialectic, not linear [57].

All forms of qualitative data analysis presuppose the existence of detailed textual data, such as observational field notes, interview transcripts, or documents. There also is a tendency to treat as "textual" other nonnumeric forms of data, such as diagrams or photographs. A necessary first step in data analysis, prior to all of the subsequent techniques, consists of reading the data. This reading is done to gain familiarity with what is going on and what people are saying or doing, and to develop initial ideas about the meaning of these statements and events and their relationships to other statements and events. Even at later stages in data analysis, it often is valuable to go back and reread the original data in order to see if the developing hypotheses make sense. All of the analysis techniques described below depend on this prior reading; they require the ongoing judgment and interpretation of the researcher.

There are four basic techniques of qualitative data analysis: (1) coding, (2) analytical memos, (3) displays, and (4) contextual and narrative analysis. They are used, separately and in combination, to help identify themes; develop categories; and explore similarities and differences in the data, and

relationships among them. None of these methods is an algorithm that can be applied mechanically to the data to produce "results." We briefly discuss each of the four techniques.

Coding

The purpose of coding, in qualitative research, is different from that in experimental or survey research or content analysis. Instead of applying a preestablished set of categories to the data according to explicit, unambiguous rules, with the primary goal being to generate frequency counts of the items in each category, it instead involves selecting particular segments of data and sorting these into categories that facilitate insight, comparison, and the development of theory [46]. While some coding categories may be drawn from the evaluation questions, existing theory, or prior knowledge of the setting and system, others are developed inductively by the evaluator during the analysis, and still others are taken from the language and conceptual structure of the people studied. The key feature of most qualitative coding is that it is grounded in the data [45] (i.e., it is developed in interaction with, and is tailored to the understanding of, the particular data being analyzed).

Analytical Memos

An analytical memo is anything that a researcher writes in relationship to the research, other than direct field notes or transcription. It can range from a brief marginal comment on a transcript, or a theoretical idea incorporated into field notes, to a full-fledged analytical essay. All of these are ways of getting ideas down on paper, and of using writing as a way to facilitate reflection and analytical insight. Memos are a way to convert the researcher's perceptions and thoughts into a visible form that allows reflection and further manipulation [7,46]. Writing memos is an important analysis technique, as well as being valuable for many other purposes in the research [5], and should begin early in the study, perhaps even before starting the study [58].

Displays

Displays, such as matrices, flowcharts, and concept maps, are similar to memos in that they make ideas, data, and analysis visible and permanent. They also serve two other key functions: data reduction, and the presentation of data or analysis in a form that allows it to be grasped as a whole. These analytical tools have been given their most detailed elaboration by Miles and Huberman [7], but are employed less self-consciously by many other researchers. Such displays can be primarily conceptual, as a way of developing theory, or they can be primarily data oriented. Data-oriented displays, such as matrices, can be used as an elaboration of coding; the coding categories are presented in a single display in conjunction with a

reduced subset of the data in each category. Other types of displays, such as concept maps, flowcharts, causal networks, and organizational diagrams, display connections among categories.

Contextual and Narrative Analysis

Contextual and narrative analysis has developed mainly as an alternative to coding (e.g., [59]). Instead of segmenting the data into discrete elements and resorting these into categories, these approaches to analysis seek to understand the relationships between elements in a particular text, situation, or sequence of events. Methods such as discourse analysis [60], narrative analysis [59,61], conversation analysis [62]; profiles [63], or ethnographic microanalysis [64] identify the relationships among the different elements in that particular interview or situation, and their meanings for the persons involved, rather than aggregating data across contexts. Coffey and Atkinson [65] review a number of these strategies.

Software

Qualitative methods produce large amounts of data that may not be readily amenable to manipulation, analysis, or data reduction by hand. Computer software is available that can facilitate the process of qualitative analysis [66,67]. Such programs perform some of the mechanical tasks of storing and coding data, retrieving and aggregating previously coded data, and making connections among coding categories, but do not "analyze" the data in the sense that statistical software does. All of the conceptual and analytical work of making sense of the data still needs to be done by the evaluator. There are different types of programs, some developed specifically for data analysis, and others (including word processors, textbase managers, and network builders) that can be used for some of the tasks of analysis. For relatively small-scale projects, some qualitative researchers advocate not using *any* software besides a good word processor. A very sophisticated and powerful program may be difficult to use if it has unneeded features, so it is advisable to carefully consider what the program needs to do before committing to its use. Weitzman and Miles [66] and Weitzman [67] provide a useful list of questions to consider in choosing software.

Validity

Validity in qualitative research addresses the necessarily "subjective" nature of data collection and analysis. Because the researcher is the instrument for collecting and analyzing data, the study is subjective in the sense of being different for different researchers. Different researchers may approach the same research question by collecting different data or by interpreting the same data differently.

Qualitative researchers acknowledge their role as research instruments by making it an explicit part of data collection, analysis, and reporting. As in collecting and analyzing any data, what the evaluator brings to the task—his or her biases, interests, perceptions, observations, knowledge, and critical faculties—all play a role in the study.

Qualitative researchers include in their studies specific ways to understand and control the effects of their background and role. They recognize that the relationships they develop with those studied have a major effect on the data that can be gathered and the interpretations that can be developed [8,12]. The researcher's relationships and rapport with study participants significantly influence what people will reveal in interviews and the extent to which they alter their behavior in response to an observer's presence. Similarly, researchers recognize that their personal experiences and theoretical bents influence their choice of evaluation questions, data, and interpretation. Qualitative researchers consider it their responsibility to carefully articulate previous beliefs and constantly question every observation and every interpretation so as to help avoid being blinded or misdirected by what they bring to the study [68]. They also report their backgrounds to study participants and the audience for the evaluation, including the research community, so that others may consider the potential influence on study results.

The product of any qualitative analysis is an interpretation, rather than a purely "objective" account. It often is valuable for several researchers to analyze the same data and compare results, but discrepancies between different researchers' interpretations do not automatically invalidate the results. Because of the flexibility and individual judgment inherent in qualitative methods, reliability generally is weaker than in quantitative designs, but validity often is stronger; qualitative researchers' close attention to meaning, context, and process make them less likely to ask the wrong questions or overlook or exclude important data [69]. Thus, the loss of reliability is counterbalanced by the greater validity that results from the researcher's flexibility, insight, and ability to use his or her tacit knowledge.

To further insure validity, qualitative researchers typically assess specific validity threats during data collection and analysis by testing these threats against existing data or against data collected specifically for this purpose [5,7,69–72]. Particular strategies include: (1) collecting rich data, (2) paying attention to puzzles, (3) triangulation, and (4) feedback or member checking, and (5) searching for discrepant evidence and negative cases. We discuss each of these in turn.

Rich Data

Rich data are data that are detailed and varied enough that they provide a full and revealing picture of what is going on, and of the processes involved [73]. Collecting rich data makes it difficult for the researcher to see only

what supports his or her prejudices and expectations and thus provides a *test* of one's developing theories, as well as provides a basis for generating, developing, and supporting such theories.

Puzzles

One underlying assumption of qualitative methods is that things make sense [74]. They make sense to the people involved in the setting, who understand the situation in ways the research must discover or determine. Moreover, the evaluator must make sense of things. If the evaluator has not understood how sense is to be made of a situation, the evaluator has not yet achieved an adequate interpretation, perhaps because not enough data have been collected, or because the problem is being approached from the wrong perspective or theoretical framework. In particular, the evaluator must pay careful attention to resolving surprises, puzzles, and confusions as important in developing a valid interpretation [75].

Triangulation

Qualitative researchers typically collect data from a range of individuals and settings. Multiple sources and methods increase the robustness of results. Using more than one source of data and more than one method of data collection allows findings to be strengthened by cross-validating them. This process generally is known as "triangulation" [15].

When data of different kinds and sources converge and are found congruent, the results have greater credibility than when they are based on only one method or source [15,33,49,76]. However, when the data seem to diverge, in line with the assumption that things make sense and the importance of focusing on puzzles or discrepancies, an explanation must be sought to account for all of them [77].

Feedback or Member Checking

This is the single most important way of ruling out the possibility of misinterpreting the meaning of what participants say and do or what the researcher observed, and the perspective the participants have on what is going on. Feedback, or member checking, involves systematically gathering feedback about one's conclusions from participants in the setting studied [47] and from others familiar with the setting. The researcher checks that the interpretation makes sense to those who know the setting especially well. In addition, this is an important way of identifying the researcher's biases [5] and affords the possibility for collecting additional important data.

Searching for Discrepant Evidence and Negative Cases

Identifying and analyzing discrepant data and negative cases is a key part of the logic of validity testing in qualitative research. Instances that cannot

be accounted for by a particular interpretation or explanation can point up important defects in that account. There are strong pressures to ignore data that do not fit prior theories or conclusions, and it is important to rigorously examine *both* supporting and discrepant data. In particularly difficult cases, the only solution may be to report the discrepant evidence and allow readers to draw their own conclusions [23].

Example

We illustrate how issues of reliability and validity can be addressed by drawing on Kaplan and Duchon's study.

In the clinical laboratory information system evaluation, Kaplan had a systems designer's working knowledge of computer hardware and software, and of terminology in clinical settings, and in particular, with order entry and results reporting systems for a clinical laboratory. She was aware that this background influenced her study. As the primary field researcher, she could listen to, and participate in, discussions among laboratory staff and have a better understanding of them. In designing the study, Kaplan, an information systems specialist, sought colleagues with backgrounds different from hers. Duchon, a specialist in organizational behavior, was unfamiliar with clinical laboratories and with information systems. Each of these two researchers had to be convinced of the other's interpretations. Further, the study's sponsors and participants were aware of the researchers' backgrounds, which also were reported in publications so that others would be able to consider for themselves what effects the researchers' backgrounds might have.

Kaplan and Duchon collected data from multiple sources using several different methods. This provided them with rich data that led to puzzles and discrepancies that required resolution. Resolving these resulted in significant insights. For example, Kaplan and Duchon explored the puzzle presented by interviewees repeatedly saying the computer system would not change laboratory technologists' jobs but that it would change what technologists did. Kaplan and Duchon developed hypotheses and tentative theories to explain how the interviewees might not see a contradiction in their statements.

They also cross-validated their results by comparing their data. Qualitative and quantitative data at first seemed not to agree. The quantitative data initially indicated no differences among laboratories in their response to the computer system, yet differences were evident in the qualitative data. Discrepancies also occurred in only the qualitative data because technologists in the same laboratory disagreed over whether the computer system was a benefit. Rather than assuming that some technologists simply were wrong, or that either the qualitative or quantitative data were in error, an explanation was needed to allow for all these responses.

Resolving these puzzles and reconciling all the data contributed to a much richer final interpretation that resulted in a theory of how views of

one's job and views of a computer system are related. Study results were made available to laboratory managers for comment, and presented to laboratory directors for discussion, thus creating opportunities for feedback and member checking of the researchers' interpretations. Further feedback was obtained by presenting the theory to staff from the laboratories studied as well as to knowledgeable individuals from other, related settings.

Units and Levels of Analysis

Often qualitative evaluation research focuses on individuals and then groups individuals in familiar ways, for example, by occupation or location. Important differences among the individuals may be obscured by grouping them together in this way. For example, in the Kaplan and Duchon study, individual technologists could be categorized based on how they conceptualized their jobs, and also the individual laboratories within the institution could be so categorized. Simply considering the category "laboratory technologist" would have lost these findings and revealed little of interest in how laboratory technologists responded to the new laboratory information system. Further, there are alternatives to taking individuals as units of analysis. Researchers can study how communities pursue their goals through using information technology [78] or conduct evaluations that cross organizational, geographic, or political boundaries through virtual health care [79]. Research designs might employ different degrees of granularity and different units and levels of analysis, and investigate how changes ripple across them [6].

Conclusion

We have presented an overview of qualitative research and how it can be used for evaluating computer information systems. This chapter has covered techniques for data collection and analysis, and discussed how and why such methods may be used. We have suggested research designs and data collection and analysis approaches that meet methodological guidelines useful when developing an evaluation plan: (1) focus on a variety of technical, economic, people, organizational, and social concerns; (2) use multiple methods; (3) be modifiable; (4) be longitudinal; and (5) be formative as well as summative [80–82].

We believe that qualitative methods are useful because they provide means of answering questions that cannot be answered solely by other methods. The strengths of qualitative methods relate primarily to the understanding of a system's specific context of development and use, the ways developers and users perceive the system, and the processes by which the system is accepted, rejected, or adapted to a particular setting. We believe that these are crucial issues for the development, implementation, and evaluation of computer information systems. Consequently, qualitative

methods can make an important contribution to research and evaluation of computer information systems.

Additional Reading

Qualitative Methods

Patton [10] is an excellent introduction to qualitative research methods. It also is one of the best works on qualitative approaches to evaluation. More advanced discussion of theory and methods of qualitative research can be found in Hammersley and Atkinson [8] and in Denzin and Lincoln [9].

Specific techniques for qualitative data analysis are presented in Miles and Huberman [7], Coffey and Atkinson [65], and Strauss and Corbin [46]. A useful guide to both data analysis and writing of qualitative research is Wolcott [58].

Rogers's [24] work on the adoption of innovations is relevant to the introduction of computer information systems.

Information Systems Research Theory and Methodological Frameworks

Useful discussions of theoretical perspectives in information systems research can be found in several papers. Kling [83], Kling and Scacchi [4], Lyytinen [84], and Markus and Robey [29] present theoretical frameworks that are relevant to studies of the social aspects of computing. The paradigms of information systems development Hirschheim and Klein [37] discuss also are applicable to research approaches and, in fact, were derived from such a framework. Kaplan [43] illustrates the influences of theoretical stance using a medical information system as an example. Mumford, Fitzgerald, Hirschheim, and Wood-Harper [85]; Nissen, Klein, and Hirschheim [86]; Lee, Liebenau, and DeGross [11]; and Kaplan, Truex, Wastell, Wood-Harper, and De Gross [13] reflect trends in information systems research methods, including the development of qualitative research methods in this area.

Evaluation Studies of Computing Systems

Lundsgaarde, Fischer, and Steele [35] conducted an exemplary evaluation of a medical information system that combines both qualitative and quantitative methods. The study's primary results are summarized in Fischer, Stratman, and Lundsgaarde [36]. Kaplan and Duchon [16] give a detailed account of how a medical system evaluation actually progressed, including issues pertaining to combining qualitative and quantitative methods. Kaplan [30,31] reports qualitative methods and findings of the study, and Kaplan and Duchon [32] include quantitative results.

Both and Kaplan [2] and Kaplan and Shaw [6] cite a number of excellent qualitative studies. Kaplan explains the advantages of using qualitative methods for evaluating computer applications, while Kaplan and Shaw provide a comprehensive critical review of evaluation in medical informatics.

Turkle [87,88] and Zuboff [89], though not concerned with applications of computers in medicine, each superbly illustrate the kind of observations and analysis possible by using qualitative methods. Walsham [90] provides discussion and examples of an interpretive approach to studying information systems.

Glossary

Analytical memo (or memo, for short): Broadly defined, any reflective writing the researcher does about the research, ranging from a marginal comment on a transcript, or a theoretical idea incorporated into field-notes, to a full-fledged analytical essay.

Case study: An empirical inquiry that investigates a phenomenon within a specific natural setting and uses multiple sources of evidence.

Coding: Segmenting the data into units and rearranging them into categories that facilitate insight, comparison, and the development of theory.

Context: The cultural, social, and organizational setting in which a study is conducted, together with the history of and influences on the project and the participants in it. Context also includes the relationships between the evaluation sponsor, the researchers, and those who work in or influence the setting.

Contextual analysis or narrative analysis: Analyzing the relationships between elements in a particular text, situation, or sequence of events.

Display: Any systematic visual presentation of data or theory; elaborated as a method of qualitative data analysis by Miles and Huberman [7].

Ethnography: A form of qualitative research that involves the researcher's relatively long-term and intensive involvement in the setting studied, that employs participant observation and/or open-ended interviewing as major strategies, and that attempts to understand both the cultural perspective of the participants and the influence of the physical and social context in which they operate.

Field notes: Detailed, descriptive records of observations.

Field research: See *fieldwork*.

Fieldwork or field research: The researcher's direct engagement in the setting studied.

Formative evaluation: Evaluation of a developing or ongoing program or activity. The evaluation is aimed at improving the program or activity while it is being developed or implemented. See *summative evaluation*.

Grounded theory: A theory that is inductively derived from, and tested against, qualitative data during the course of the research; also, an approach to qualitative research that emphasizes this method of theory development [45,46].

Induction: A process by which generalizations are made from many particular instances found in the data.

Iteration: Repetition of a series of steps, as in a repeating cycle of data collection, hypothesis formulation, hypothesis testing by more data collection, additional hypothesis formulation, etc.

Member checking: Getting feedback from participants in the study to check the researchers' interpretation.

Narrative analysis: See *contextual analysis*.

Open-ended interviewing: A form of interviewing that does not employ a fixed interview schedule, but allows the researcher to follow the respondent's lead by exploring topics in greater depth and also by pursuing unanticipated topics.

Open-ended questions: Interview or survey questions that are to be answered in the respondent's own words, rather than by selecting preformulated responses.

Participant observation: A form of observation in which the researcher participates in the activities going on in a natural setting and interacts with people in that setting, rather than simply recording their behavior as an outside observer.

Qualitative research: A strategy for empirical research that is conducted in natural settings, that uses data in the form of words (generally, though pictures, artifacts, and other non-quantitative data may be used) rather than numbers, that inductively develops categories and hypotheses, and that seeks to understand the perspectives of the participants in the setting studied, the context of that setting, and the events and processes that are taking place there.

Rich data: Data that are detailed, comprehensive, and holistic.

Robustness: Interpretations, results, or data that can withstand a variety of validity threats because they hold up even if some of the underpinnings are removed or prove incorrect.

Summative evaluation: Evaluation that is aimed at assessing the value of a developed program for the purpose of administrative or policy decisions. This evaluation often is done by testing the impact of the program after it has been implemented. See *formative evaluation*.

Triangulation: The cross-checking of inferences by using multiple methods, sources, or forms of data for drawing conclusions.

Validity: The truth or correctness of one's descriptions, interpretations, or conclusions.

Validity threat: A way in which one's description, interpretation, or conclusion might be invalid, also known as "rival hypothesis" or "alternative explanation."

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