THE REPERTORY GRID TECHNIQUE: A METHOD FOR THE STUDY OF COGNITION IN INFORMATION SYSTEMS

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ABSTRACT

Recent studies have confirmed the importance of understanding the cognition of users and information systems (IS) professionals. These works agree that organizational cognition is far too critical to be ignored as it can impact on IS outcomes. While cognition has been considered in a variety of IS contexts, no specific methodology has dominated. A theory and method suitable to the study of cognition - defined as personal constructs that individuals use to understand IT in organizations - is Kelly's (1955) Personal Construct Theory and its cognitive mapping tool known as the repertory grid (RepGrid). This article expounds on the potential of this technique to IS researchers by considering the variety of ways the RepGrid may be employed. The flexibility of the RepGrid is illustrated by examining published studies in IS. The diagnostic qualities of the RepGrid and its mapping outcomes can be used for practical intervention at the individual and organizational levels.

Keywords: cognitive mapping, Repertory Grid, Personal Construct Theory, qualitative research, quantitative research

ISRL Categories: IB01, AC07, AI01, AI0801, AI0802

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INTRODUCTION

As the uses of information technology (IT) in organizations increase in both variety and complexity, practitioners and researchers are searching for ways to better understand how various information system (IS) stakeholders (users, managers, information system professionals) think about IT in their organizations. Orlikowski and Gash (1994) argue that understanding the assumptions, expectations, values, and beliefs (i.e., the thinking or cognition) of these stakeholders can lead to more successful information systems outcomes. Understanding cognition is becoming increasingly important for a number of areas of management study including strategic management (Walsh, 1995), organizational change (Simpson and Wilson, 1999), and organization knowledge (Spender, 1998). In IS, there is a strong and growing interest in studying how people think about the information systems and technology they develop and use (Barley, 1986; Compeau, et al., 1999; DeSanctis and Poole, 1994; Griffith and Northcraft, 1996; Lind and Zmud, 1991; Nelson, et al., 2000; Orlikowski and Gash, 1994).

A cognitive approach to studying IS in organizations is therefore not new. While cognition has been considered in a variety of IS contexts, no specific methodology has taken hold. The purpose of this paper is to describe a technique that can be used for the study of cognition in information systems – The Repertory Grid Technique. This technique offers the potential to significantly enhance our understanding of how users, managers and IS professionals make sense of IT in their organizations.

Sensemaking in organizations begins with the personal perspectives individuals use to understand and interpret events that occur around them. Terms that have been used to describe these personal perspectives include "schemas" (Cossette and Audet, 1992; Jelinek and Litterer, 1994), "cognitive maps" (Eden, 1992; Weick and Bougon, 2001), "technological frames" (Orlikowski and Gash, 1994), and "mental models" (Daniels et al., 1995). While there is a variety of definitions of cognition in the literature (Eden and Spender, 1998), in this paper we employ Kelly's (1955) term "personal constructs" to define cognition in information systems. Kelly refers to an individual set of perspectives as a system of personal constructs and suggests that these personal constructs can be shared to a greater or lesser extent.

Cognition has traditionally been thought of as individually created and structured (Arnold and Nicholson, 1991; Shaw, 1980). However, cognition at the organizational level is an area of growing interest and importance in strategic management and research (Eden and Spender, 1998; Huff, 1990; Weick, 2001). The sharing of personal constructs has implications of both commonality, involving cognition that is held in common between organizational members, and individuality, which consists of individual cognitions that contribute to the organizational pool (Simpson and Wilson, 1999). In this paper, we adopt Weick's (1995; 2001) approach and assume that it is possible to understand organizational cognition and hence organizational action, by measuring and understanding individual cognition or personal constructs. This approach is gaining increased recognition primarily due to the growing acceptance of the notion that organizations possess cognitive capabilities and that these cognitive characteristics influence action (Weick and Bougon, 2001; and Calori et al., 1992). It makes the individual's cognition "… the foundation of a new paradigm of how organizations work and how people within organizations achieve shared action" (Jelinek and Litterer, 1994:33). This approach represents a shift from a perspective that considers individual actions as determined by events external to the individual, to actions emerging from the sensemaking activities of individuals or groups within the organization (Weick 1995; 2001).

We therefore propose that the personal constructs that individuals apply to understanding IT and its role in organizations can be explored using Kelly's (1955) Personal Construct Theory and its methodological extension, the Repertory Grid Technique (RepGrid). The RepGrid is a cognitive mapping technique that attempts to describe how people think about the phenomena in their world. The RepGrid technique, for IS, entails a set of procedures for uncovering the personal constructs individuals use to structure and interpret events relating to the development, implementation, use, and management of IT in organizations. The meaning individuals ascribe to an event is anchored in its antecedents and consequents (Kelly, 1970). Previous applications of the RepGrid technique to organizational studies include organizational design (Wacker, 1981), organizational dynamics (Dunn and Ginsberg, 1986), strategic groups (Reger and Huff, 1993) and managerial competencies (Cammock, et al., 1995). In IS, the technique has been applied to the study of "excellent" systems analysts (Hunter, 1997; Hunter and Beck, 2000) and IS project risk factors (Moynihan, 1996).

This article provides a comprehensive discussion of the issues that researchers need to consider when employing the RepGrid technique. Based upon a variety of published IS studies, we elaborate on alternative ways of designing and implementing the RepGrid. IS research that has used the technique (Hunter, 1997; Hunter and Beck, 2000; Latta and Swigger, 1992; Moynihan, 1996; and Phythian and King, 1992) discusses its use in terms of specific research objectives. These works discuss the application of the RepGrid in a highly specific manner - either qualitatively, quantitatively, idiographically, or nomothetically. While these articles provide a valuable contribution in a specific context, they do not present as comprehensive a discussion of the subject, as does this article. Turning to these works directly will give the IS researcher a limited insight into the technique. Thus, notwithstanding the contribution made by the above articles, the discussion here represents a holistic approach by assessing various ways to design and implement the RepGrid technique. We hope that it will serve as an addition to the methodological tool-kit for the IS researcher intending to investigate the personal constructs of individuals and groups regarding IT in organizations.

We begin by considering the relevance of the RepGrid technique to IS research. This is followed by an overview of Kelly's (1955) Personal Construct Theory and an elaboration of the basics of the RepGrid technique. A variety of published IS research that has employed the RepGrid is used to illustrate the flexibility of the technique and the importance of making the appropriate design decisions at the beginning of a research project where the RepGrid will be employed. We conclude by considering the strengths of the RepGrid technique and its underlying theory for investigating and documenting the personal constructs of individuals regarding IT within an organizational context.

RELEVANCE TO INFORMATION SYSTEMS RESEARCH AND PRACTICE

A common objective of management research that uses the RepGrid is to improve organizational action. Some researchers intervene directly at the organizational level, examining differences in collective maps of groups (Daniels, et al., 1994a; Simpson and Wilson, 1999), while others prefer to achieve this indirectly, by exploring differences in individual maps (Dutton, et al., 1989; Walton, 1986). In addition, mapping permits the researcher to observe changes in the cognitive infrastructures of individuals and groups over time (Fournier, 1996).

IS research and practice can benefit from these emancipatory qualities of the RepGrid by supporting individual diagnosis and management/organizational intervention. From a Personal Construct Theory perspective, the application of the RepGrid can provide insights into the quality of the understanding between groups such as Line and IT managers (Reich and Benbasat, 2000) and between users and technologists (Lind and Zmud, 1991). The cognitive maps produced can display the understandings held in common by these groups. Furthermore, the maps can also reveal the differences in constructs between Line/users and IT management/technologist groups. These maps can provide the platform upon which the overall group can collectively diagnose disagreements. Individual group members can gain greater awareness of what the issue looks like from the other's standpoint through cross-level absorbing (Eden, 1992). This is where individual-level maps absorb characteristics of common-level maps and conversely, common-level maps absorb characteristics of individual-level maps. This can provide a basis for increasing understanding through collective diagnosis and management of disagreements. Kelly's (1955) construct theory and its RepGrid can assist individual users, managers and technology providers in the subjective analysis of their own understanding, leading the individual to modify this understanding, if necessary.

Furthermore, published cognitive IS research can also be informed by the application of the RepGrid. For example, a revealed causal mapping approach was used in a study of software operations support expertise (Nelson, et al., 2000). This study used open interview techniques. Fifty support experts were interviewed. With the use of the RepGrid technique, fifteen to twenty five participants would have been adequate to generate sufficient constructs to reveal the extent of the characteristics of support expertise. The full context and minimum context elicitation processes, in conjunction with "laddering", could have permitted the researchers to arrive at the core constructs – ie. characteristics that are central to the individual's interpretation of support expertise. In addition, the rating scales used to complete the RepGrid would have produced numbers to permit the statistical comparison of support experts based on industry differences or differences in experiences. The empirical testing of research hypotheses could also be possible.

The RepGrid can also add value to cognitive approaches like Adaptive Structuration Theory (AST) (DeSanctis and Poole, 1994; Poole and DeSanctis, 1990). Structuration is the process by which groups create and maintain a social system through the application of structures. In the research into the use of advanced information technologies, structures include the rules and resources provided by the technology, the task, organizational culture, group norms, and the knowledge represented by participants (DeSanctis and Poole, 1994). The RepGrid technique can be used to elicit the personal constructs of individuals and groups of individuals regarding the use of such advanced technologies. Constructs that are shared among groups within the organization can yield information about group norms. The RepGrid can also assist IS researchers in exploring the core constructs that make up the culture at the organizational level. In addition, the technique has been used in knowledge acquisition in the development of expert systems (Boose, 1986; Hart, 1986) and can be applied in acquiring the knowledge of users in the context of advanced information technologies.

Details of the RepGrid are discussed in the next section. We illustrate the flexibility of the technique using a variety of published IS research.

PERSONAL CONSTRUCT THEORY AND THE REPGRID

Kelly (1955) argues that individuals use their own personal constructs to understand and interpret events that occur around them and that these constructs are tempered by the individual's experiences. Thus, individuals come to understand the world in which they live by developing a personally organized system of interpretation based on their experiences. The function of a personal construct system is to interpret the current situation and to anticipate future events. Further, individuals can share and appreciate to varying degrees the personal construct systems of others. Indeed, Kelly argues in his commonality corollary that the extent of similarity of psychological processes between two persons depends upon the similarity of their personal construct systems. Furthermore, Kelly contends that personal constructs are bi-polar in nature. For instance, employees may organize their experiences with the organization's senior management team into those that have good leadership skills and those with poor leadership skills, or those who are good communicators and those who are poor communicators. "Good Leadership Skills - Poor Leadership Skills" and "Good Communicator - Poor Communicator" are considered the bi-polar constructs used by employees to categorise the organization's senior management team. The use of bi-polar labels increases understanding of how a construct may be employed by an individual to facilitate interpretation.

The technique used to determine personal construct systems is the RepGrid. The RepGrid contains three major components – elements, constructs, and links (Easterby-Smith, 1980):

1. Elements are the subject within the domain of investigation. They define the entities upon which the administration of the RepGrid is based. For example, to explore the critical success factors (CSFs) of IS projects, IS researchers can use IS projects as elements in the RepGrid.
2. Constructs represent the research participant's interpretations of the elements. Further understanding of these interpretations may be gained by eliciting contrasts resulting in bi-polar labels. Using the same example, research participants may come up with bi-polar constructs such as "high user involvement – low user involvement" to differentiate the elements (i.e., IS projects). The labels represent the CSFs of IS projects.
3. Links are ways of relating the elements and constructs. The links show how the research participants interpret each element relative to each construct. Further, the links reveal the research participant's interpretations of the similarities and differences between the elements and constructs. From the example above, a seven-point rating scale can be used to get participants to differentiate between the IS projects (i.e., elements) along each elicited CSF (i.e., construct).

In general, elements are the objects of the research participant's interpretations while constructs are labels attributed to these interpretations. Constructs are bi-polar, indicating how elements are interpreted as similar or different from others. Various methods may be employed to link elements and constructs. The following section discusses the design alternatives facing the IS researcher, and how the objectives of the investigation may affect the specific design of the RepGrid technique.

RepGrid Design Decisions

Researchers must choose between design alternatives before beginning their use of the RepGrid. We provide examples from past IS research to illustrate the variety of choices possible. These examples are summarized in Table 1. The examples were chosen in an attempt to present as much variety as possible in the use of the RepGrid technique. In one example, Hunter (1997) employed the RepGrid technique to elicit from users and IS professionals their interpretations of what constitutes the qualities of "excellent" systems analysts. Another example by Moynihan (1996) used the RepGrid technique to gather from project managers their interpretations of the situational factors relating to the planning and carrying out of systems development projects. Further, Phythian and King (1992) employed the RepGrid technique to identify key factors that influenced manager-experts in evaluating tenders or proposals. Finally, Latta and Swigger (1992) used the RepGrid technique to identify group understanding of system interfaces.

Element Selection

The elements represent aspects considered important within a specific domain of discourse. Elements may be people, such as systems analysts (Hunter, 1997), or activities, such as systems development projects (Moynihan, 1996). There are two basic ways of selecting elements. One way is for the researcher to provide the elements (commonly referred to as supplied elements). The other way is to ask the research participant to provide them (elicited elements).

Several reasons have been proposed that support the researcher supplying the elements (Reger, 1990). Firstly, researchers may choose to provide the elements if they are interested in learning more about a given set of elements from various research participants. Secondly, researchers may wish to let an existing theory guide element choice. Finally, researchers may also be interested in comparing responses of a number of respondents given a standard set of elements. This reason is especially important if the researcher desires to compare the results within a homogeneous group of individuals or across different groups. In the examples in Table 1, Phythian and King (1992) and Latta and Swigger (1992) supplied the elements in their study.

Alternatively, researchers may choose to request the participant to provide his/her own elements to ensure that the elements are relevant to the participant. This can be done in a variety of ways (Easterby-Smith, 1980):

- Researcher can provide role or situation descriptions – for example, specifying roles of people in the organization or types of experiences in the organization. Participants are then asked to provide his/her own specific examples to fit these general categories.
- Researcher can define a "pool" – for example, participants are asked to "name five subordinates", to "name three effective and three ineffective managers" or to "list six leisure activities that you have indulged in".
- Researcher can elicit through discussion – in this case, the investigator and participant discuss the topic of interest and a list of elements is drawn up jointly.

In the examples in Table 1, Hunter (1997) and Moynihan (1996) provided role and situation descriptions respectively in order to elicit the elements in their studies.

There are a number of rules for selecting supplied or elicited elements. Firstly, elements must be discrete (Stewart and Stewart, 1981). For example, commonly used elements in organizational research are people, objects, events, and activities – in other words, nouns and verbs. Researchers need to be very precise when selecting elements – specific nouns and specific verbs - for example, systems development projects (Moynihan, 1996) and customer enquiries (Phythian and King, 1992). Secondly, elements must be homogeneous (Easterby-Smith, 1980). That is, elements should be drawn from the same sample. For example, people and objects must not be mixed. The reason for this is that constructs that are generated from elements in one category are not likely to be applicable to those in another category. Thirdly, elements must not be evaluative (Stewart and Stewart, 1981). For example, evaluative words like motivation, leadership, knowledge, and communication can be often mistakenly used in order to elicit the qualities of successful managers. Instead, perhaps names of different managers should be used. This relates to the discrete nature of elements. In each of the examples in Table 1, elements are drawn from one category and are not evaluative - for example, systems analysts that the research participant has interacted with (Hunter, 1997) or components of online bibliographic retrieval systems (Latta and Swigger, 1992). Finally, elements should be representative of the area to be investigated (Beail, 1985; Easterby-Smith, 1980). Researchers must ensure that all research participants can relate to the selected elements. Further, it is important that research participants select a range of elements. If elements are selected that the research participant would consider being either positive or negative, a much richer set of constructs and interpretations can be elicited. In the example of Moynihan (1996), research participants were asked to provide successful and unsuccessful systems development projects as the elements.

Construct Elicitation

The RepGrid technique allows for several different methods of eliciting constructs. In some of these methods, researchers can apply minor variations and combinations (Beail, 1985; Easterby-Smith, 1980; Reger, 1990).

First, the researcher can provide the constructs (supplied constructs). By supplying constructs, the researcher can compare individual RepGrids in a statistical manner. For example, constructs elicited from the instructor were supplied to participating students in order to compare the commonality in their construct systems regarding the design of system interfaces (Latta and Swigger, 1992).

Second, the constructs may be elicited from triads (minimum context form). This method is considered the classical approach to generating constructs and is known as the triadic sort method. The minimum context form involves the random selection of three elements (triads) at a time from the repertory of elements for each elicitation. The participant is asked to identify (and label) some way in which two elements are similar yet different from the third relative to the domain of discourse. The researcher may leave the issue of similarities and differences open-ended, allowing the research participant to choose any labels that are relevant to him or her. Alternatively, researchers may provide contextual cues that focus the research participant's attention on a specific research issue.

The process of identifying similarities and differences is intended to produce contrasting poles for the construct (i.e., the bi-polar nature of constructs discussed in the previous section). The elicitation process is then repeated until the researcher is satisfied that all relevant constructs have been identified. Previous research suggests that seven to ten triads are sufficient in most domains to elicit all of the participant's constructs in the domain (Reger, 1990). All four examples in Table 1 used this form of construct elicitation. A variation of this procedure is the sequential form, where triads of elements are also presented and the same questions are asked of the participant. The difference is that instead of randomly selecting the elements, the researcher systematically substitutes the triads. Thus, the first triad would contain elements A, B, and C; the second B, C, and D; the third C, D, and E; and so on until all elements in the sample have been presented. Other variants of the triadic process include combining supplied and elicited constructs (Easterby-Smith, 1980); eliciting constructs from dyads – i.e., presenting two elements at a time (Keen and Bell, 1980); using only a sample of the full repertory of elements elicited to generate constructs (Dutton, et al., 1989); and asking research participants for the opposite label instead of asking how the third element differs from the other two in the triad (Epting, et al., 1971).

The third elicitation technique is known as the "full context form". It involves presenting the full repertory of elements and requesting the research participant to sort the repertory into any number of discrete piles based on whatever similarity criteria the research participant chooses to apply. After the sorting is completed, the research participant will be asked to provide a two to three word descriptive title for each pile of elements. This procedure is used to elicit the similarity judgments. A matrix showing element relationships can be developed and examined using statistical methods. The full context form has been used for research into understanding cognitive groupings (Reger and Huff, 1993) and shared meaning in organizations (Simpson and Wilson, 1999). None of the examples in Table 1 employed the full context form of elicitation, as the method does not elicit the kind of data required to answer the research questions in these examples.

The final alternative approach is group construct elicitation (Stewart and Stewart, 1981). In this method, all research participants involved in the study are gathered together with the researcher facilitating the group "workshop". The researcher may either ask each participant to name the elements on cards or to call out the elements. All research participants then collectively agree on the elements in the RepGrid. Bi-polar constructs are then elicited using the minimum context elicitation technique. Any of the above elicitation techniques may be employed. When the construct elicitation phase is completed, the researcher will facilitate the rating of the elements along each of the constructs identified by all individuals. Constructs are gathered from all research participants and randomly selected in this process. The open discussion that ensues allows all research participants to share interpretations. Group construct elicitation serves two purposes. The first is data collection – it is a highly economical and less time consuming way of eliciting constructs. The second is that of team building – it allows each research participant to see the different interpretations other group members have and may assist in their understanding and appreciation for different viewpoints within the group. None of the examples in Table 1 elicited constructs using this approach.

A process known as “laddering” may also be employed in conjunction with all of the above elicitation techniques. Laddering permits the research participant to further elaborate on the elicited construct. A series of general probing questions (i.e. How and Why) may be employed. In effect, the researcher is drilling down into the construct in order to determine the research participant’s underlying assumptions and interpretations of the label associated with the construct. For example, Phythian and King (1992) and Hunter (1997) used laddering to obtain the meanings behind the constructs elicited through the minimum context form. Laddering is further elaborated elsewhere (Reynolds and Gutman, 1988).

Linking Elements to Constructs

There are three methods of linking elements to constructs – dichotomizing, ranking, and rating. In dichotomizing, a tick is placed against the element closest to the left pole of the construct. If it is closest to the right pole, a cross is placed. This method of linking is like a simple sort routine or a rating scale with only two points. It allows research participants to associate elements with either side of the bi-polar construct. The problem with this method is it does not allow for shades of gray (Beail, 1985). Participants have to select one pole or the other. Another problem is that it can potentially produce a skewed distribution (Easterby-Smith, 1980). To avoid skewed distributions, participants are sometimes instructed to make sure that the elements are divided equally between ticks and crosses on each construct. This again may not always be what the research participant desires.

Ranking elements was originally used as an alternative to dichotomizing as it removed the problem of a skewed distribution (Beail, 1985). Ranking involves placing the elements in an order between the two contrasting poles of the construct. Ranking provides much greater discrimination than dichotomizing, but it may force research participants to indicate differences between elements where really no difference exists. Participants were asked to rank elements in Phythian and King (1992).

The method most often employed to link elements and constructs is rating (Hunter, 1997; Latta and Swigger, 1992). This method allows the research participant greater freedom when sorting the elements and does not force the research participant to make discriminations that do not exist. Rating scales of five, seven, nine, or eleven points have been used. Participants in Latta and Swigger's (1992) study were asked to rate elements along constructs using a five-point scale, while Hunter (1997) used a nine-point rating scale. The rating freedom of research participants is maximized when the range of rating values is greater than the number of elements. Others argue that the discrepancies between retest reliabilities for those research participants who had the freedom to choose the rating scales and those who have a rating scale imposed was least for the five-point category rating (Bell, 1990). It has been suggested that a seven-point scale approaches most participants’ limits of discrimination and that anything much above a five-point scale is very difficult to examine visually (Stewart and Stewart, 1981).

In some instances, elements and constructs may not be linked. For example, Moynihan (1996) was primarily interested in the constructs and the labels participants attached to these constructs. Using content analysis, Moynihan was able to identify the themes or categories underlying the construct labels used by the participants. As such, rating, ranking, or dichotomizing elements along each elicited construct served no purpose.

RepGrid Analysis

The RepGrid literature describes several approaches to reorganizing the raw RepGrid data (Beail, 1985; Bell, 1990; Easterby-Smith, 1980; Gaines and Shaw, 1980; Leach, 1980; Stewart and Stewart, 1981). These approaches allow the researcher to examine the relationship among elements and among constructs as well as between elements and constructs. These approaches are discussed in detail in this section.

Content Analysis: This can be a simple frequency count - the researcher counts the number of times particular elements or constructs are mentioned. This method is used to examine the data for common trends among the research participants (Hunter, 1997; Moynihan, 1996). Alternatively, the researcher can select categories into which constructs fall and then assign the constructs to categories (Stewart and Stewart, 1981).

Rearranging the RepGrid: This method of analyzing a RepGrid simply rearranges the RepGrid by changing the order of elements and constructs. The rows and columns are shuffled so that similar constructs are positioned close to each other and consequently similar elements are placed in proximity to each other (Bell, 1990; Easterby-Smith, 1980). This reordering of rows and columns can reveal similarities and differences among constructs and elements. This may also involve reversing the construct poles in order to easily highlight patterns in the RepGrid. This process of rearranging the RepGrid is known as “visual focusing” (Hunter, 1997). Stewart and Stewart (1981) provides an extended illustration of visual focusing.

Transforming the RepGrid: By transforming the RepGrid, the researcher can better understand the relationships between and among elements and constructs. Correlation matrices can be obtained for both elements and constructs simply by counting the number of matches in pairs of elements and constructs. Cluster analysis can be applied to the RepGrid data to identify patterns and major groupings of constructs and hence elements. A technique called FOCUS, introduced by Shaw and Thomas (1978), uses hierarchical cluster analysis to transform the RepGrid. The RepGrid when analyzed using cluster analysis appears with constructs and elements rearranged (i.e., an electronic form of visual focusing).

Decomposing the RepGrid: This method simplifies the RepGrid data by breaking it down into fundamental structures using principal components analysis. Factor analysis of RepGrids is a very popular method of analyzing them (Bell, 1990; Easterby-Smith, 1980; Leach, 1980). According to Bell (1990), most RepGrids can be satisfactorily approximated by two or three factors (i.e. have more than 80% of the variance explained). As such, elements and/or constructs can be plotted in two or three dimensional space to reveal the basic structure of the RepGrid.

Analyzing Content and Structure: The RepGrid technique yields measures of cognitive content and structure of an individual’s construct system. These indices of content and structure can be compared across individuals.

Cognitive content can be described in three ways: element distance, construct centrality and element preference. These content descriptions were first proposed by Kelly (1955) and widely reviewed in the Personal Construct Theory literature (Dunn, et al., 1986; Fransella and Bannister, 1977; Slater, 1977).
(i) Element distance refers to the distance between elements and measures the perceived similarity among elements. Elements that are considered similar are elements that are rated similarly on all constructs. Those that are rated differently on all dimensions are perceived to be different. Element distance describes the differences in the meanings of the elements as perceived by participants. Element distance can be calculated by conducting a vertical analysis of the RepGrid. Examples include computing inter-element distance statistics (Dunn, et al., 1986) or using cluster analysis (Reger, 1990). Elements that are close together in meaning will have low inter-element distance values, while those that are far apart will have high inter-element values.
(ii) Construct centrality refers to the importance of a construct in relation to all other constructs. Kelly (1955) theorized that certain constructs might be central to all individuals’ system of constructs. Constructs with high centrality are those that are highly correlated to every other construct. These correlations can be obtained by conducting a horizontal analysis of the RepGrid. Correlation values can be acquired directly from a correlation matrix or indirectly from a factor analysis (Reger, 1990).
(iii) Element preference is the perceived desirability of each element in relation to all other elements. An element that is more preferred is one that has a higher average score than another element, as measured by column means in the RepGrid.

Cognitive structure can be described and compared in three ways: cognitive differentiation, cognitive complexity and cognitive integration. Univariate indices of all three measures of RepGrid structure have been reviewed widely (Dunn, et al., 1986; Fransella and Bannister, 1977; Slater, 1977). Multivariate analysis, such as factor analysis, may be used to explore two aspects of RepGrid structure – complexity and integration (Reger, 1990).
(i) Cognitive differentiation refers to the number of constructs used to compare and contrast elements. A highly differentiated system of interpretation has many constructs, while one with low differentiation has few constructs. Cognitive differentiation can be measured by simply counting the number of constructs elicited.
(ii) Cognitive complexity is the degree to which each construct is different in meaning from every other construct. It is measured by conducting a horizontal analysis of the RepGrid (i.e., by examining the correlations among the constructs). A highly complex system of interpretation has low correlations among constructs and thus each construct is used independently to add additional information about the elements. A system of interpretation with

low complexity is one in which all constructs are highly correlated and thus each adds little information about the elements. Complexity can be measured using multivariate methods, which simultaneously consider correlations among all pairs of constructs or by determining the index of frame complexity (Dunn, et al., 1986).
(iii) Cognitive Integration refers to the degree of linkage between constructs. It is the inverse of complexity and is measured in the same way. A highly integrated system of interpretation is characterized by high correlations, while one with low integration has low correlations.

Analyzing Commonality and Collectivity

The above discussion focuses on different methods of analyzing individual RepGrids. Similarities in cognition between individuals and groups of individuals can be measured using three different approaches (Ginsberg, 1989).

First, linguistic analysis can be used to classify groups of common constructs. This method was used in a study to classify descriptions into construct categories of financial terms (Walton, 1986). Linguistic analysis is a cumbersome procedure, but it focuses on the research participant’s own expressions, thereby minimizing researcher bias in interpreting descriptions.

Second, mapping techniques such as Q-type factor analysis and multidimensional scaling (MDS) can also be used to map collective meanings among individuals or groups of individuals. In the Q-type technique, distance scores are first correlated across individuals. The resulting correlation matrix is then subjected to Q-factor analysis that yields clusters of individuals in terms of the best linear combination of distance scores for all pairs of elements. MDS was developed to help understand research participant's subjective judgments of similarities and differences between a set of objects. The aim of MDS is to determine the configuration of elements in multidimensional space. Points are arranged in this space such that pairs of elements that are more frequently judged similar appear closer together. The resulting normative map represents a best-fit distribution of points based on the judgments of all the research participants who provided ratings of element similarities.

Third, multivariate techniques such as analysis of variance, regression analysis and discriminate analysis can be used to analyze the pooled results of individual RepGrid structures. This approach aims to identify groups of individuals with similar levels of cognitive structure. This technique permits the traditional testing of hypotheses.

In addition, indices of cognitive content and structure can be used to explore the collective understanding of groups within an organization. Several alternatives are available for examining collective content and structure (Dunn and Ginsberg, 1986). One approach is to conduct a construct inventory by listing constructs named by a group of research participants and plotting their relative frequencies. Another option is to identify the set of constructs held by most members. A third approach is to systematically construct and analyze a “who-to-whom” matrix of participants within an organization. In this approach, measures of cognitive content and structure are gathered for each individual (as discussed in the previous section). Convergence scores are then entered for these values onto a who-to-whom matrix, where converging measures are coded as “1” and diverging measures are coded as “0”. A comprehensive discussion of this approach can be found in Ginsberg (1989).

Sample Size

The intensive nature of the RepGrid technique often means a relatively small sample size. A sample size of fifteen to twenty five within a population will frequently generate sufficient constructs to approximate the “universe of meaning” regarding a given domain of discourse (Dunn, et al., 1986; Ginsberg, 1989). That is, no new constructs are normally added even if the sample size is increased. For instance, in Dunn et al. (1986), seventeen respondents generated a total of twenty-three unique constructs. These constructs were completely generated after the tenth interview. The last seven interviews, according to Dunn et al. (1986) added no new constructs. In addition, studies using the RepGrid with a small sample size can be used to develop items for larger sample instruments such as questionnaires.

INFORMATION SYSTEMS RESEARCH USING THE REPGRID

Four published examples are discussed to further elaborate how the RepGrid technique can be applied to IS research (see Table 1). These examples have successfully used the technique to investigate the personal constructs of users, managers and IS professionals relating to the development, use, and management of IT. Just as Lee (1991) used an exemplar to illustrate a framework integrating positivist and interpretive approaches, and just as Klein and Myers

(1999) demonstrated the usefulness of a set of principles for interpretive field studies in IS by evaluating three examples, so we employ a similar approach by analyzing four articles that clearly illustrate the variety of ways the RepGrid technique can be designed and employed to explore cognition in information systems.

In these examples, the RepGrid was used to investigate a variety of IS issues from either a qualitative or quantitative perspective. Within these, research using the RepGrid can be either idiographic or nomothetic in nature. As a result, the design of the technique reflected these different perspectives. As indicated earlier, turning to these works directly will give the IS researcher a limited insight into the technique. In the ensuing sections, we therefore provide a broader discussion as to what the IS researcher should consider when designing the RepGrid to support qualitative/quantitative and idiographic/nomothetic investigations. Examples from Table 1 are used to further illustrate a specific point.

Qualitative vs. Quantitative

The identification of emerging themes from elicited constructs is common in a qualitative approach using the RepGrid. Two of the examples in Table 1 used the technique in a qualitative manner. For example, Hunter (1997), when investigating how certain groups of individuals interpreted the qualities of "excellent" systems analysts, employed content analysis of the data gathered from individual interviews conducted using the RepGrid technique. The numeric component of the RepGrid was only employed to conduct visual focusing at the end of each interview as a means of quickly assessing what had transpired during the interview and whether the research participant agreed with this initial assessment. Hunter used computer software (COPE) to assist in the data analysis mainly to manipulate the data in support of identifying emerging themes. Similarly, Moynihan (1996) employed the RepGrid technique to elicit interpretations from research participants regarding what aspects were considered important when deciding upon an approach to adopt for projects to be conducted for external clients. An individual RepGrid was developed for each research participant. Then the data were analyzed from a qualitative perspective via content analysis at the construct level where emerging themes were identified and categorized.

In contrast, the quantitative approach utilizes mathematical and/or statistical analyses of RepGrid data. These techniques are commonly used to explore the structure and content of an individual's construct systems (i.e., cognitive complexity and frame typification) or make comparisons between groups of individuals (Ginsberg, 1989). This approach was adopted in two of the examples in Table 1. For instance, Phythian and King (1992) assessed key factors relating to decisions about whether to proceed with a competitive proposal by a large engineering organization. Statistical analyses (specifically, cluster analysis using FOCUS and correlation analysis) were conducted on individual and combined RepGrids. These data were used to support the development of an expert support system (ESS). The conclusions were that the resulting ESS was a fair representation of the decision-making process that existed at the time. Similarly, Latta and Swigger (1992) applied cluster analysis and Spearman's rank order correlation to explore the similarity of the interpretations among students and their instructor regarding user interface designs. The study revealed an overall correlation between the students' and the instructor's RepGrids, promoting the utility of the RepGrid technique in modeling knowledge related to the design of information systems.

Idiographic vs. Nomothetic

Early applications of the RepGrid were used in clinical psychology where the emphasis was on the idiographic characteristics of personal construct systems. The idiographic approach focuses on the subjective experiences of the individual and presents results in expressions and terms used by the individual. The resulting RepGrid is considered unique in that there are no common elements or constructs employed in the elicitation process. For example, in the study of systems analysts, the participants were asked to name up to six systems analysts with whom they had interacted (Hunter, 1997). In this project, Hunter provided a role description (i.e. system analysts interacted with) and asked each participant to specify examples that fit this category. The analysts named were not common among participants and as such the resulting RepGrids were not common in terms of the elements used. However, emerging themes were identified based on the research participants' construct elaborations. Similarly, Moynihan (1996) asked the participating project managers to make a list of systems development projects they had worked on as a project manager. If the project managers named more than nine projects, they were then asked to choose the three that were the most successful, the three that were the least successful, and three in between. Moynihan's research objective was to identify the situational factors project managers regard as important when planning new development projects, and not to compare the personal constructs of different project managers. As such, Moynihan did not supply a common set of systems development projects that would have permitted a comparative analysis of individual RepGrids.

Hunter (1997) and Moynihan (1996) both used content analysis to identify emerging themes in their respective projects. IS researchers interested in the idiographic characteristics of individual unique RepGrids are not restricted to analyzing the elicited RepGrid data purely from a qualitative perspective. Although none of the examples in Table 1 illustrate projects that have applied quantitative analysis to idiographic RepGrids, the strategic management literature affords some examples. For instance, in a study comparing the degree of coherence in strategic teams between companies, participants were asked to produce a list of key factors in their business environment that were taken into account when forming strategies (Simpson and Wilson, 1999). This resulted in a list of factors for each participating company. These factors were used as the elements in the RepGrid interviews for each company. The elicited data were then analyzed using multidimensional scaling, correlation and cluster analyses. Similarly, Daniels et al. (1994a) required participants to state the companies they perceived to be competitors in the North Sea offshore pump industry. The data were then analyzed using various statistical tests – the Cochran Q Test, Helmert contrasts and ANOVA. The study concluded that the cognitions of managers are not homogeneous and that diversity increases as functional and company boundaries are crossed.

In contrast, research comparing the RepGrids of individuals or groups of individuals requires different decisions to be made concerning the elements and constructs in the RepGrid process. This nomothetic approach necessitates the use of a common set of elements and/or constructs to permit comparisons to be made between RepGrids (Easterby-Smith, 1980). Such research also tends to be quantitative in nature. For example, Phythian and King (1992) used a common set of customer enquiries as elements in the RepGrid process. This permitted the comparison of the construct systems of the two managers based on their personal experiences of similar events. These constructs were then used in the development of an expert support system. In another example, a set of constructs was elicited from an instructor and then supplied as common constructs to a group of students. These students were asked to evaluate these constructs against a prescribed set of elements representing the features of online bibliographic retrieval systems (Latta and Swigger, 1992). This permitted the similarity in the interpretations among students and between students and the instructor to be tested. In these examples, the reason for the use of common components in the RepGrid process was to compare the data. Other reasons supporting the use of supplied elements and/or constructs were mentioned earlier in this paper.

The strategic management literature, however, provides an exception to the use of supplied elements and constructs (Daniels, et al., 1994a). This study successfully compared idiographically elicited RepGrids with other idiographically elicited RepGrids. The authors presented each manager with a booklet containing a variety of cognitive maps generated by visual card sort, cluster and principal components analyses. These maps represented the manager's own maps and maps from a randomly selected member of the same company with the same management function; a randomly selected member of the same company with a different management function; a randomly selected member of a different company with the same management function; a randomly selected member of a different company with a different management function; and a map randomly generated from the manager's own named competitors. The managers were asked to rate the similarity of each of these maps to their own mental model on a five-point fully anchored Likert-type scale. The resulting data were then analyzed using Cochran's Q test, ANOVA, and Helmert contrasts. A comprehensive introduction to the technique of rating the similarity between maps and issues of reliability and validity of the method are discussed elsewhere (Daniels et al., 1994b). This method of comparing RepGrid data and resulting cognitive maps is particularly attractive to the IS researcher who does not necessarily wish to impose structure into the RepGrid process. It is an alternative to supplying a set of prescribed elements and/or constructs that may limit the participants' responses.

Finally, none of the four examples in Table 1 approached their studies using both qualitative and quantitative approaches. This does not imply that the RepGrid cannot lend itself to both qualitative and quantitative analysis of the collected data. For example, in Hunter's (1997) study participants were asked to rate the elements along each of the elicited constructs. In this study, the data in the resulting RepGrids could have been statistically analyzed to produce maps derived from cluster or factor analysis. Hunter did not design his study with the objective to compare the RepGrids across his sample. By eliciting both elements and constructs, Hunter was setting the study to explore the idiographic characteristics of the participants' construct systems. Had Hunter set out to compare the similarity and differences in the RepGrids across his sample, he would have had to use a common set of elements or constructs or both. The use of common elements and/or constructs permits comparisons to be made. Alternatively, Hunter would have had to ask the participants to rate the similarity of a variety of maps including their own. In the case of Moynihan (1996), quantitative analyses could only be possible if he had asked his participants to rate the study's elements and constructs. Rating would have permitted the RepGrid to be completed and would have then provided the data for further quantitative analyses

CONCLUSION

We consider the RepGrid technique to be a valid and useful method that can be employed to investigate the personal constructs that users and IS professionals use to interpret IT and its role in organizations. Its main strength is that the technique reaches the shared and unique components of individuals' cognitive construction systems (Kelly, 1955). In addition, the RepGrid is an accepted research tool in psychology (Bannister, 1981), and in the management field, it is an increasingly accepted and utilized methodology for mapping the cognitive structure and content of individuals (Reger, 1990). Furthermore, the RepGrid provides data that can be analyzed qualitatively or quantitatively through statistical methods. The discussion of published IS research that has used the RepGrid clearly illustrates this point. The diagnostic qualities of the RepGrid permit practical intervention. Recent calls for relevance (Benbasat and Zmud, 1999; Robey and Markus, 1998) and a broader approach to relevance in IS research (Lee, 1999) agree that more emphasis should be placed on applied theories and methods that can produce utilizable and consumable deliverables that can serve as effective diagnostic tools for management intervention. The RepGrid and its products can help bring more relevance to the IS discipline. The mapping outcomes can be used for intervention both at the individual as well as the organizational level (Fiol and Huff, 1992).

Finally, we would like to conclude by reiterating two important points. First, the RepGrid can be used in conjunction with other methods as a means of validating other techniques or as a “preliminary” phase to further interpretive or positivist investigations. The second point is that the Personal Construct Theory is one of several theories in cognitive science (Berkowitz, 1978). Similarly, the RepGrid is one of several cognitive mapping methods available to the IS researcher (Huff, 1990). This paper was written in an attempt to stimulate interest in the IS research community in a valid and useful method for the study of cognition in IS. The RepGrid and its mapping outcomes can be used for individual and organizational level intervention.

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Table 1: Examples of IS Research Using the RepGrid

	Hunter (1997)	Moynihan (1996)	Phythian and King (1992)	Latta and Swigger (1992)
Research Objectives	Explore the qualities of "excellent" systems analysts	Identify the situational factors considered in the planning/running of new systems development projects	Develop rules for an expert system to support customer tender evaluations	Validate the RepGrid in modelling communal knowledge regarding design of system interfaces
Research Perspective	Qualitative	Qualitative	Quantitative	Quantitative
Nature of RepGrid	Idiographic	Idiographic	Nomothetic	Nomothetic
Key Findings	Several themes considered as qualities of "excellent" systems analysts	Identified themes over and above literature. Differences in project managers' construction of project contexts	Identified key factors and rules influencing tender decisions. Expert system improved consistency	Commonality of constructions support the use of the RepGrid to model group knowledge
Research Design:				
Element Selection	Systems analysts participant has interacted with	Systems development projects participant has worked on	Previous customer tender enquiries	Components of online bibliographic retrieval systems
	Elicited	Elicited	Supplied	Supplied
Construct Elicitation	Qualities of "excellent" systems analysts	Situational factors influencing risks in new systems projects	Key factors and rules influencing tender decisions	Attributes of system interface design
	Minimum context form (triadic sort) and laddering	Minimum context form (triadic sort)	Minimum context form (triadic sort) and laddering	Minimum context form (triadic sort) and supplied constructs
Linking	Rating	None	Rating (Grid) Ranking (Elements)	Rating
RepGrid Analysis	Content analysis Visual focusing COPE and VISA	Content Analysis	Cluster analysis (FOCUS), correlation, mathematical modelling	Cluster analysis. correlation
Sample and Size	53 (users and IT professionals) from two insurance companies	14 systems development project managers	Two manager-experts involved in assessing tender enquiries	Instructor and students who completed an "information search and retrieval" course

Appendix A

Personal Construct Theory
Corollaries

Fundamental Postulate: A person's processes are psychologically channelized by the ways in which s/he anticipates events (Kelly, 1955:46).

People tend to behave like scientists attempting to understand and relate to their environment. They develop their own interpretation of reality, which they employ to interpret and predict current and future interactions with their environment.

1. Construction Corollary: A person anticipates events by construing their replications. (Kelly, 1955:49).
   People use their interpretations of previous events to predict how to react to future events.
2. Individuality Corollary: Persons differ from each other in their construction of events. (Kelly, 1955:55).
   Peoples' interpretations of events are never identical and may differ considerably.
3. Organization Corollary: Each person characteristically evolves, a construction system embracing ordinal relationships between constructs. (Kelly, 1955:56) to aid in anticipating events.
   People create their own personal system of constructs, which may be flexible depending upon the situation.
4. Dichotomy Corollary: A person's construction system is composed of a finite number of dichotomous constructs. (Kelly, 1955:59).
   Every construct is expressed in terms of a person's own use of labels to describe bipolar terms.
5. Choice Corollary: A person chooses that alternative in a dichotomized construct through which s/he anticipates the greater possibility for extension and definition of his/her system. (Kelly, 1955:64).
   People try to improve the usefulness of the system of personal constructs.
6. Range Corollary: A construct is convenient for the anticipation of a finite range of events only. (Kelly, 1955:68).
   Individual constructs apply to a certain range of convenience.
7. Experience Corollary: A person's construction system varies as s/he successively construes the replications of events. (Kelly, 1955:72).
   People may revise their system of constructs based upon their new interpretations of events.
8. Modulation Corollary: The variation in a person's construction system is limited by permeability of the constructs within whose range of convenience the variants lie. (Kelly, 1955:77).
   Some people are less willing to change their interpretations based upon new experiences.
9. Fragmentation Corollary: A person may successively employ a variety of construction subsystems that are inferentially incompatible with each other. (Kelly, 1955:83).
   While people tend to employ a consistent pattern of personal constructs, there may be situations where contradictory action may be taken.
10. Commonality Corollary: To the extent that one person employs a construction of experience that is similar to that employed by another, his/her processes are psychologically similar to those of another person. (Kelly, 1955:90).
    There is the possibility that people do interpret the same events in a similar manner.
11. Sociality Corollary: To the extent that one person construes the construction processes of another, s/he may play a role in a social process involving the other person. (Kelly, 1955:96).
    People are able to interact well with others when they are able to understand others interpretations.