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Seeking the Dimensions of Decision-Making: An Exploratory Study

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It is a capital mistake to theorize before one has data. – Sir Arthur Conan Doyle¹

In this paper the decision-orders framework, developed by Scherpereel (2002), is used to initiate an exploratory study. The study is designed to identify the underlying dimensions of decision problems so that they can be better understood and objectively evaluated. The results are validated using interviews, and to isolate the terminology that is commonly found in the target population's language set.

The first section focuses upon the measurement instrument background followed by a brief summary of the purpose for conducting this exploratory study. This section also identifies the research questions being considered. The second section provides the theory upon which study is based. A brief non-technical statement of the methodology, a description of how these methods are implemented, and an overview of the limitations to consider when evaluating the research, follow the theory section. The results are then presented and analyzed. The concluding section provides a summary of the findings and describes how these findings can be used in future decision dimension studies.

BACKGROUND

A major problem with conducting business research studies is that the concepts being measured are abstract and complex and the tools available are relatively crude and primitive. The objective of business research studies is to get a valid measurement of the object under investigation. In the physical sciences the measurement tools can be accurate; there is very little relative difference between the measured or test value and the actual or true value. The temperature measurement taken from a standard mercury thermometer would probably be accepted without significant debate. Unfortunately, measuring abstract business concepts, like decision-orders, which often have multiple interrelated dimensions, do not evoke such standard measurement instruments. Thus, the relatively crude nominal or preferred ordinal and interval measures developed by empirical researchers do not offer satisfying confidence. In business research, the question always remains; how well do the measured results reflect the actual values? This issue is tempered by utilizing standard measurement techniques or their variants.

This next section discusses a standard measurement instrument that is utilized in this research. Although repeated research has given indication of its validity, the application employed here is unique. The intent is to hold relatively true to the methodology as originally developed, and to make only minor modifications to the implementation as dictated by the specific research problem.

Semantic Differential

The semantic differential is a scaling and research methodology developed by Osgood et al. (1957) to measure the psychological meaning of an object to an individual. The technique is developed to deal with the multiple dimensions of meaning and to explore the latent, or hidden, dimensions that cannot be directly measured. It is based on the proposition that any object, or concept, can be located in a multidimensional property space by the words, or semantics, used to describe it. For example, the semantic differential may be used to identify how the meaning of the word "cow" differs from the meaning of the word "pig." The multidimensional representation evolved is called the semantic space.

The semantic differential technique can be compared to the psychological technique of using associations to elucidate some repressed disorder. It is a method of indirect investigation that reveals information, which would

¹ From The Adventures of Sherlock Holmes, "Scandal in Bohemia" (1892).

be difficult or impossible to garner through direct questioning. The technique has been widely used in marketing, political, organizational, and informational research.² For example, in a study on information quality and information alignment, the semantic differential technique was used to identify the latent dimensions of what constitutes quality information (Lefebvre 1992). In a marketing study on brand image, the technique was used to compare different brands of beer (Mindak 1969). In both these studies, its primary purpose was to identify the dimensions on which to focus change.

The semantic differential technique as originally developed consists of a set of bipolar rating scales, usually seven points,³ on which respondents are requested to rate one or more concepts. The general format as described by Osgood et al. (1957) can be found in Figure 1, along with an example in which the concept of “polite” is semantically differentiated. The claim is made by Snider and Osgood that “the terms ‘extremely,’ ‘quite,’ and ‘slightly’ as linguistic quantifiers have been associated with more or less equal degrees of intensity” (Snider and Osgood 1969, p. 67). Data and support for this claim are offered in their book, “The Measurement of Meaning” (Osgood, Suci et al. 1957). This assumption allows the proponents of the semantic differential technique to justify their data analysis techniques by declaring that the ordinal data collection method results in approximately interval data.

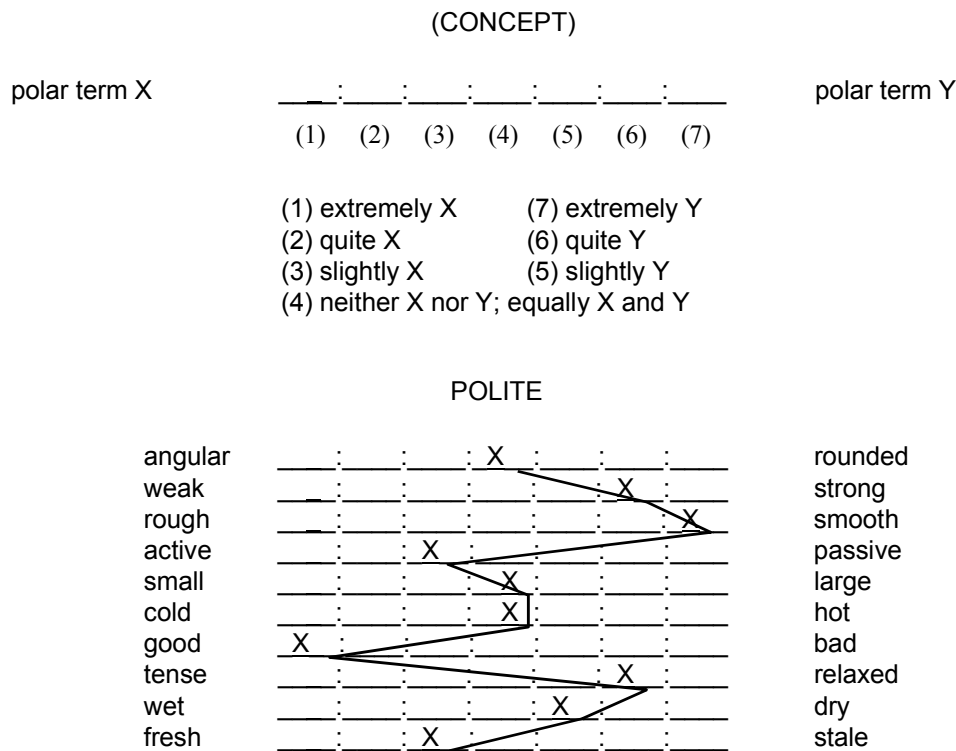


Figure 1: General Format for Semantic Differential (Osgood et al., 1957)

² A sampling of applications can be found in: (Kernan and Sommers 1967; Mindak 1969; Szalay and Deese 1978; Hirschman 1980; Levy 1981; Friedman 1986; Thayer 1990; Lefebvre 1992; Alliger, Tannenbaum et al. 1997; Scharlemann, Eckel et al. 1999).

³ A 1980 review of rating scale research by E. P. Cox, concluded that there should be between five and nine levels in a scale (Cox 1980). This conclusion is consistent with Miller’s (1954) thesis, titled “The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information.” It is clear from this research that too many divisions of a scale’s continuum leads to dimensioning returns and confusion, while too few divisions results in an inability to discriminate what may be significant differences.

In the development of the semantic differential methodology, Osgood et al. (1957) started with a list of 289 polar adjectives generated from Roget's Thesaurus. These were screened down to 76, which were then formulated into rating scales. They tested these 76 polar opposites on 20 different concepts. The results of a factor analysis⁴ indicated that three factors contributed consistently to most meaningful judgments by the participants. The major factors that emerged were labeled evaluation, potency, and activity. Osgood et al. (1957) make the claim that these three factors are somehow stable across concepts and populations. This stability claim has been disputed in a number of studies.⁵ In fact, these studies have demonstrated that there exists "dramatic concept-scale interaction and considerable rater-scale interaction" (Cronkhite 1977, p. 65).

It is suggested that the semantic differential technique can be generalized. However, these generalizations should be done with the necessary adaptation for each research problem (Emory 1985). The first development step is not controversial. It involves selecting the concepts to be studied. These concepts reflect the nature of the problem under investigation and they are often selected based on judgment. The next step is selecting the specific bipolar word pairs for each scale. Researchers differ on whether the original scales developed by Osgood et al. (1957) should be implemented or whether it is appropriate to tailor the scales to the specific problem. There is evidence that confirms the original scales usefulness in field research (Peters and Kuhn 1970), while there exists equally convincing evidence that tailor-made scales are more appropriate (Sharp and W. Thomas Anderson 1972; Dickson and Albaum 1977). Given the concern with factor stability, if the bipolar scales are theoretically developed the choice whether to use standard or tailor-made scales is best left to the researcher.

This supposition is consistent with Gary Cronkhite's (1977) suggestion that those who are interested in using the semantic differential technique to measure how a given population perceives a specific concept should first conduct a pretest factor analysis. The factor analysis will help identify the dimensions on which that specific population perceives the concept and the scales that most represent those dimensions. This is the same methodology originally employed by Osgood et al. (1957), and suggests that the semantic differential technique has evolved from a set of general factors that apply to all concepts, to a methodology of first discovering the latent dimensions of a specific problem and then measuring the population's response along those unique dimensions. This methodology results in more intuitively appealing relationships and new discipline specific insights.

Benefits of the Semantic Differential for Decision-order Evaluation

The decision-order framework is developed as an objective classification taxonomy (Scherpereel 2002). However, since humans are intimately involved in the application of the taxonomy, it is their subjective perceptions of these objective factors that must be captured. The semantic differential is developed specifically to measure perceptions. While other techniques have been developed to measure perceptions, the semantic differential offers three key advantages. The first advantage is that the ordinal data collected, when properly described,⁶ can be analyzed using interval techniques. This assumption may justify the use of some of the powerful parametric statistical techniques.

Unlike other scaling techniques, the semantic differential can measure perceptions in both direction and intensity. The scales are designed to capture a directional measure of the concept relative to some neutral or central position and simultaneously provide data on how intensely the individual rates the concept. A response near the poles of a semantic differential scale indicates stronger concept agreement with the word on that pole than a response near the scales center or neutral point. The complete set of responses for a single concept provides a comprehensive picture of the concept's meaning and yields data on an individual's perception of the concept's meaning.

Finally, the technique allows for the extraction of a large amount of information in a relatively short period of time. To get both intensity and directional information using other scaling techniques requires much longer and more complex questionnaires. An alternative might be using open-ended questionnaires or interviews. These methods however, are not efficient at capturing a standardized image of the concept. Although they might be useful for exploring the appropriate terminology to incorporate in the semantic differential questionnaire, these alternatives

⁴ Factor analysis is the generic name for a group of multivariate statistical techniques that attempt to define the underlying structure of the data set matrix.

⁵ See (Heise 1969; Wiggins and Fishbein 1969; Rosenbaum, Rosenbaum et al. 1971; Miron 1972; Shikiar, Fishbein et al. 1974).

⁶ See Osgood et al. (1957)

produce results that are difficult to aggregate. The ability to capture information about a specific concept quickly and aggregate it easily is probably the greatest advantage of the semantic differential technique.

Objectives

This study has a single primary objective: to develop a short-list of feasible bipolar semantic scales that indicate the underlying dimensions of decision problems. However, it also provides a useful exploratory environment for examining, refining, and formulating several theoretical hypotheses. Support is sought for the theoretical a-priori hypotheses that decisions have multiple dimensions and these dimensions can be measured. It is also hypothesized that certain semantic scales provide proxy measures for the proposed dimensions. Nonetheless, the study is not designed to provide rigorous proof for these claims. It does not collect the data necessary to perform tests for statistical significance. It is not designed to control for even the most confounding parameters. Lastly, the sample size does not provide the data needed for standard statistical data reduction procedures.⁷

However, it does provide information necessary for achieving the primary objective. The decision dimension study is certainly useful in providing credible evidence for reducing the set of feasible semantic scales. The study also delivers some exploratory, non-statistical, support for the decision-order taxonomy. It suggests that empirical validation is possible and sets the stage for future research.

THEORY

The fine art of executive decision consists in not deciding questions that are not now pertinent, in not deciding prematurely, in not making decision that cannot be made effective, and in not making decisions that others should make (Barnard 1938, p. 194).

Are decisions multidimensional? The extensive literature seems to suggest that decisions are indeed multidimensional.⁸ If this premise is assumed validated by extensive literature, then what are the dimensions? On this question, the literature remains relatively silent. There are certainly indications, suggestions, and allusions to what these dimensions might be, but there is no general theory. Osgood et al. (1957) developed the semantic differential technique to explore the dimensions of meaning for a specified concept. Can this technique be used to explore the dimensions of “decisions” as a concept? The answer, yes, has been assumed in this paper.

This paper is the first to explore and identify the dimensions of decisions. It takes the previous theoretical work, used in developing decision-order theory (Scherpereel 2001), and identifies the essential descriptive terminology. These terms are then searched for polar opposites; placing first-order descriptors opposite third-order descriptors, along a hypothetical scale. For example, the term “simple,” a first-order term, will be placed on the opposite pole of the semantic scale from the term “complex,” a third-order term. In some cases it is clearer for the respondents to have the second-order term placed opposite a first-order term.⁹ An example of this is placing “probabilistic” at the opposite pole from “deterministic.”¹⁰

The compiled list of semantic scales is then divided into the scales that better describe decision “characteristics” and the scales that better describe decision “approaches.” This is the list of semantic scales from which the short-list will be identified. Table 1 provides this complete list of decision-specific polar opposites.

⁷ Standard statistical data reduction procedures would include principal component analysis or factor analysis.

⁸ Additional information on the multidimensionality of decision problems can be found in (Barnard 1938; Lindblom 1959; Thompson 1981; Klein 1998; Gharajedaghi 1999).

⁹ This is the case were the second-order term is commonly perceived by the respondents to be the true polar opposite of the first-order term.

¹⁰ Note that the third-order term “heuristic” is not always in the common language set of the respondents. Thus, to avoid confusion the scale is truncated at the second-order. This is acceptable, since several scales will be aggregated to indicate a particular dimension. The only requirement is that the final composite dimension must range from 1st to 3rd order.

Decision "Characteristics"

[1] Simple - Complex	[23] Could be calculated - Could not be calculated
[2] Current Focused - Future Focused	[24] Black and White - Grey
[3] Predictable - Unpredictable	[25] Unimportant - Important
[4] Concrete - Abstract	[26] Constrained - Unconstrained
[5] Revocable - Irrevocable	[27] Stagnant - Fluid
[6] Static - Dynamic	[28] Restricted - Unrestricted
[7] Repetitive - Varied	[29] Fictional World - Real World
[8] Low Risk - High Risk	[30] Defined - Undefined
[9] Short Term - Long Term	[31] Closed - Open
[10] Constant - Changing	[32] Deterministic - Probabilistic
[11] Frequent - Infrequent	[33] Limited - Boundless
[12] Usual - Unusual	[34] Numerical - Descriptive
[13] Certain - Uncertain	[35] Many Restrictions - Few Restrictions
[14] Independent - Dependent	[36] Quantitative - Qualitative
[15] Common - Uncommon	[37] Administrative - Entrepreneurial
[16] Near - Far	[38] Operational - Strategic
[17] Quantifiable - Theoretical	[39] Safe - Risky
[18] Low Stakes - High Stakes	[40] Small - Big
[19] Clear - Ambiguous	[41] Did not change with time - Changed with time
[20] Bounded - Unbounded	[42] Reversible - Irreversible
[21] Common - Unique	[43] Easy - Difficult
[22] Narrow - Broad	

Decision "Approaches"

[44] Textbook - Gut	[74] Detailed - Big Picture
[45] Computer Driven - Human Driven	[75] Easy - Difficult
[46] Quick - Slow	[76] Search for a Single solution - Search for Many solutions
[47] Find a Best solution - Find a Usable solution	[77] Effective - Ineffective
[48] Efficient - Inefficient	[78] Calculation - Experimentation
[49] Individual - Team	[79] Select from Alternatives - Search for Alternatives
[50] Valid - Practical	[80] Disconnected - Connected
[51] Sophisticated - Unsophisticated	[81] Leisurely - Hasty
[52] Formal - Informal	[82] Evidential - Circumstantial
[53] Convergent - Divergent	[83] Systematic - Unsystematic
[54] Deliberate - Accidental	[84] Over Lunch - Over Night
[55] Explicit - Implicit	[85] Filtering - Generative
[56] Mathematics - Experience	[86] Risk Avoiding - Risk Accepting
[57] Fast - Slow	[87] Whole - Partial
[58] Anal - Willy Nilly	[88] Methodical - Haphazard
[59] Effortless - Laborious	[89] Relaxed - Stressed
[60] Exact - Approximate	[90] Planned - Unplanned
[61] Risk Avoiding - Risk Taking	[91] Saving - Gambling
[62] Unemotional - Emotional	[92] Dictatorial - Democratic
[63] Imitation - Innovation	[93] Procedural - Ad Hoc
[64] Old Method - New Method	[94] Objective - Subjective
[65] Only Complete solutions ... - Partial solutions ...	[95] Isolated - Collaborative
[66] Research - Intuition	[96] Fact Driven - Opinion Driven
[67] Organized - Disorganized	[97] Tangible - Intangible
[68] Closed - Open	[98] Active Search - Passive Search
[69] Risk Averse - Risk Preferring	[99] Provable - Usable
[70] Complete - Incomplete	[100] Unhurried - Hurried
[71] Optimal - Satisfactory	[101] Efficient - Effective
[72] Deductive - Inductive	[102] Organized - Disorganized
[73] Exact - Approximate	[103] Independent - Dependent

Table 1: Decision-specific Polar Opposites

Inspection of this list reveals some natural groupings of related terms. These natural groupings form the basis for a hypothesized five dimensional structure for decision characteristics. The five major dimensions are illustrated in Figure 2. These dimensions are labeled as follows: complexity, time, scope, risk and uncertainty.

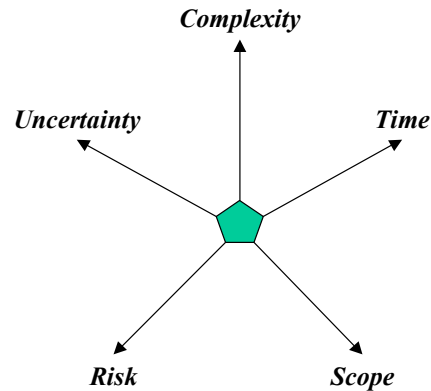


Figure 2: Hypothesized “Decision Characteristic” Dimensions

The five dimensions cannot be measured directly, but are the aggregate representations of the scales in the natural groupings. In essence, the dimensions represent semantic clusters of several similar dimensions corresponding to the natural groupings. The dimensional label along with its matching natural group of measures is shown in Table 2.¹¹ This representation is similar to Osgood et al. (1957) three-dimensional semantic space.¹²

¹¹ Note that several of the major groupings are subdivided into minor groupings, which are indicated by the bracketed terms. Possible additional dimensions can be inferred from these sub-groupings.

¹² Osgood et al. (1957) semantic space is made up of evaluation, potency, and activity dimensions. These dimensions are represented by proxy groups of measured semantic scales. For example, the dimension labeled by evaluation is measured by the aggregation of several of the following bipolar scales; good-bad, positive-negative, optimistic-pessimistic, complete-incomplete, and timely-untimely.

Decision "Characteristics"

<p style="text-align: center;">Uncertainty (Generic)</p> <p>[13] Certain - Uncertain [32] Deterministic - Probabilistic [29] Fictional World - Real World [19] Clear - Ambiguous [3] Predictable - Unpredictable</p> <p style="text-align: center;">Uncertainty (Variability)</p> <p>[12] Usual - Unusual [7] Repetitive - Varied [10] Constant - Changing [21] Common - Unique [15] Common - Uncommon [11] Frequent - Infrequent</p> <p style="text-align: center;">Complexity (Generic)</p> <p>[1] Simple - Complex [43] Easy - Difficult [14] Independent - Dependent</p> <p style="text-align: center;">Complexity (Quantitative)</p> <p>[4] Concrete - Abstract [34] Numerical - Descriptive [36] Quantitative - Qualitative [17] Quantifiable - Theoretical [30] Defined - Undefined [24] Black and White - Grey [23] Could be calculated - Could not be calculated</p>	<p style="text-align: center;">Time (Duration)</p> <p>[9] Short Term - Long Term [2] Current Focused - Future Focused [16] Near - Far</p> <p style="text-align: center;">Time (Active)</p> <p>[6] Static - Dynamic [41] Did not change with time - Changed with time [27] Stagnant - Fluid</p> <p style="text-align: center;">Scope (Scope)</p> <p>[40] Small - Big [22] Narrow - Broad [25] Unimportant - Important [26] Constrained - Unconstrained [28] Restricted - Unrestricted [31] Closed - Open [33] Limited - Boundless [20] Bounded - Unbounded [35] Many Restrictions - Few Restrictions</p> <p style="text-align: center;">Scope (Function)</p> <p>[37] Administrative - Entrepreneurial [38] Operational - Strategic</p> <p style="text-align: center;">Risk (Generic)</p> <p>[8] Low Risk - High Risk [39] Safe - Risky [18] Low Stakes - High Stakes</p> <p style="text-align: center;">Risk (Elasticity)</p> <p>[42] Reversible - Irreversible [5] Revocable - Irrevocable</p>
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Table 2: Hypothesized “Decision Characteristic” Dimensional Measures

The multidimensional factorization of the “decision characteristic” concept along these five dimensions forms the basis for the first two exploratory hypotheses (H1 and H2) in the decision dimension study:

H1: The dimensions of the “decision characteristic” concept are defined in Figure 2.

H2: The semantic differential scales constructed from the groupings in Table 2 measure the dimensions, defined in Figure 2.

Since, the natural groups are based on theory, intuition, and experience, rather than on hard empirical evidence, the decision dimension study is used to explore the semantic space for some supporting and opposing empirical evidence. Therefore, these hypotheses are exploratory in the sense that the evidence collected is used to justify modifications to the theory.

The second set of exploratory hypotheses involves the five dimensional factorization of the “decision approach” concept. Again, the same process is used. From the list of decision-specific polar opposites, Table 1, inspection is used to identify the natural groupings of related “decision approach” terms. These natural groupings are exploited to define a hypothesized five dimensional structure for decision approaches. The five major dimensions are illustrated in Figure 3. These dimensions are labeled as follows: logic, risk, scope, time, and collaboration.¹³

¹³ The use of the same labels for several of the approach dimensions as are used for the characteristic dimensions does not indicate that these dimensions are identical. The labels for the approach dimensions are chosen to provide the best descriptor for the category or grouping. These choices are made without regard to whether the term was previously used to label the dimensions in the characteristic semantic space.

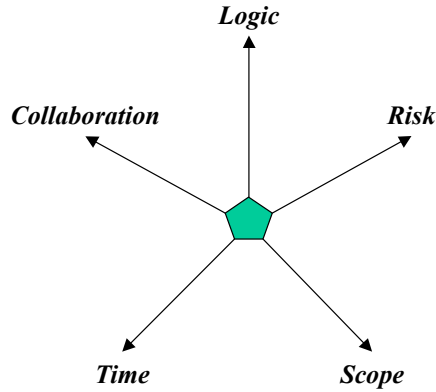


Figure 3: Hypothesized “Decision Approach” Dimensions

The five dimensions are defined by the aggregate measure of selected scales in the natural groupings. The dimensional label along with its matching natural group of measures is shown in Table 3.

Decision "Approaches"	
<p style="text-align: center;">Logic (Philosophy)</p> <p>[44] Textbook - Gut [78] Calculation - Experimentation [56] Mathematics - Experience [45] Computer Driven - Human Driven [72] Deductive - Inductive [66] Research - Intuition [82] Evidential - Circumstantial</p> <p style="text-align: center;">Logic (Procedure)</p> <p>[47] Find a Best solution - Find a Usable solution [99] Provable - Usable [71] Optimal - Satisfactory [50] Valid - Practical [51] Sophisticated - Unsophisticated [48] Efficient - Inefficient [83] Systematic - Unsystematic [93] Procedural - Ad Hoc [52] Formal - Informal [53] Convergent - Divergent [54] Deliberate - Accidental [90] Planned - Unplanned [88] Methodical - Haphazard [58] Anal - Willy Nilly [77] Effective - Ineffective [101] Efficient - Effective</p> <p style="text-align: center;">Scope (Horizon)</p> <p>[74] Detailed - Big Picture [75] Easy - Difficult</p> <p style="text-align: center;">Scope (Search)</p> <p>[76] Search for a Single solution - Search for Many solutions [85] Filtering - Generative [98] Active Search - Passive Search [79] Select from Alternatives - Search for Alternatives</p>	<p style="text-align: center;">Risk</p> <p>[61] Risk Avoiding - Risk Taking [63] Imitation - Innovation [69] Risk Averse - Risk Preferring [91] Saving - Gambling [64] Old Method - New Method [86] Risk Avoiding - Risk Accepting [65] Only Complete solutions ... - Partial solutions ... [87] Whole - Partial [68] Closed - Open [70] Complete - Incomplete [60] Exact - Approximate</p> <p style="text-align: center;">Time</p> <p>[46] Quick - Slow [81] Leisurely - Hasty [100] Unhurried - Hurried [57] Fast - Slow [84] Over Lunch - Over Night [89] Relaxed - Stressed [59] Effortless - Laborious [67] Organized - Disorganized</p> <p style="text-align: center;">Collaboration</p> <p>[49] Individual - Team [92] Dictatorial - Democratic [95] Isolated - Collaborative [94] Objective - Subjective [62] Unemotional - Emotional [96] Fact Driven - Opinion Driven [97] Tangible - Intangible [55] Explicit - Implicit [103] Independent - Dependent [80] Disconnected - Connected</p>

Table 3: Hypothesized “Decision Approach” Dimensional Measures

The multidimensional factorization of the “decision approach” concept along these five dimensions forms the basis for two additional exploratory hypotheses (H3 and H4):

H3: The dimensions of the “decision approach” concept are defined in Figure 3.

H4: The semantic differential scales constructed from the groupings in Table 3 measure the dimensions, defined in Figure 3.

This completes the theoretical development necessary to initiate the decision dimension study. From the hypothetical multidimensional semantic spaces, hypothesized above, a decision dimension study is designed to produce a short-list of feasible and appropriate bipolar scales. In the process, the hypothesized dimensions and measures are explored. Evidence for modification and refinement of these hypotheses is presented. Finally, an improved hypothetical theory is offered. This theory is the foundation on which decision dimensions are identified.

METHODOLOGY

This section briefly describes the methodology used in the decision dimension study. It takes some of the preliminary learning from a pilot study to construct a semantic differential questionnaire instrument. Since the objective of this study is to identify a short-list of feasible semantic scales, an additional rating scale is appended to each of the concept semantic differential scales. This additional rating scale is also a semantic differential type. It is included to assess the perceived difficulty, in both magnitude and direction, for each of the concept semantic scales.

Design

Each of the bipolar terms in Table 1 is placed on the opposite end of a seven-point scale. These form the basis for the semantic differential rating scales, as described by Osgood et al. (1957). For brevity reasons, only a single specific decision is selected as the concept for investigation. A total of forty-three (43) concept scales are constructed to assess the decision characteristics, and sixty (60) concept scales are focused on the decision approaches. A five-point semantic differential type assessment scale is appended to each concept scale. The assessment scales are included to measure the perceived magnitude and direction of difficulty for each of the concept scales. Thus, for each set of bipolar terms in Table 1, data are collected on the perceived magnitude, and direction, of the concept’s meaning; and an assessment is then made of the perceived difficulty in marking the scales.

Layout

As with the pilot questionnaire, the decision dimension questionnaire includes detailed instructions on the correct marking of the instrument. These instructions are presented in the three sections: general information, specific example, and important notes. Because the decision dimension study includes the “difficulty” assessment, a modification is made to questionnaire layout. Instead of having the “decision characteristic” concept next to the “decision approach” concept, as was suggested by the pilot study, the concepts are presented in serial. This allows room for the difficulty assessment, and permits the “decision characteristic” concept to be evaluated on a single page. Since only a single “decision” is being evaluated, having the two concepts in serial did not present the same problem of concept confusion identified in the pilot study. This layout is illustrated in Figure 4.

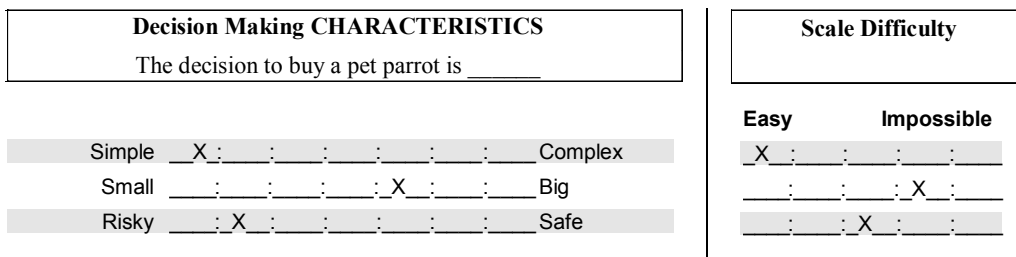


Figure 4: Decision dimension study - Question Layout

The choice of placing the “decision characteristic” concept first in the questionnaire is made for two reasons. The first being that the pilot study indicated that “decision characteristics” are easier to identify than “decision approaches,” thus, opening with the “decision characteristic” concept is consistent with placing the easier scales earlier in the questionnaire (Emory 1985, p. 222). The second reason for placing the “decision characteristic”

concept first is that the number of semantic scales is few enough to allow the entire concept to be presented on a single page. This lessens the concern with a respondent responding to the “decision characteristic” concept when marking the scales intended for the “decision approach” concept.

Scale Order

Due to the large number of items being assessed, there is a concern that respondents will mark scales arbitrarily based on the preceding scale’s mark. This is one variation of the “halo effect¹⁴.” To combat this concern, both the scale’s order and polar term’s direction are pseudo randomly generated.¹⁵ This encourages the respondent to pay close attention to the descriptors on the poles of the scale and discourages the anticipation of the next scale’s polarity.

Administration

The actual decision selected for investigation is based on the study’s target audience. In this case, a group of thirty-two “special program” master degree students is asked to participate. A common decision for this group is the decision to enter the “special program” called the Masters of Manufacturing Management (MMM), rather than the traditional Masters of Business Administration (MBA). Although this might be classified as a personal decision, eliciting more of an emotional response than a typical business decision, it is assumed that the “decision characteristic” and “decision approach” concepts would show similar relationships to those found in business decisions.

The target group is chosen primarily for access reasons, but also because of the expected, responsiveness, intelligence, and homogeneity. The researcher has direct access to the target group for both the initial administration of the questionnaire and the informal follow-up interviews. The target group members are all participants in a workshop, unrelated to the study, which is led by the researcher. This personal relationship encourages high levels of responsiveness, over 80%, to the rather lengthy and abstract questionnaire instrument.

The semantic scales in the questionnaire use vocabulary that assumes a high level of intelligence. The participants not only have to mark these scales but also have to evaluate the scale’s difficulty. These tasks cannot be entrusted to a random group from the general population.¹⁶ The masters-degree students all have demonstrated high levels of prior academic achievement, evidenced by their admission into a top-twenty business school. Thus, it is assumed that they will understand the vocabulary, instructions, and concepts introduced. With this homogeneous group, a common decision concept can be easily identified and responses can be confidently assumed reliable.

Limitations

The exploratory hypotheses laid out in this study cannot be proven rigorously for a number of reasons. First, the hypotheses are complex models of a complex theory. The model depicting the relationships implies independence when none can be reasonably assumed. For example, the easy-difficult scale that is used as a proxy measure for the “complexity” dimension can reasonably be used as one of the proxy measures for the “risk” dimension. The hypotheses are consistent with the theory but a number of alternatively reasonable variants can be formulated. Rather than attempting to formulate all the conceivable variants and claiming they are all a-priori

¹⁴ The “halo effect” is especially common when the subject being studied is not clearly defined, not easily observed, not frequently discussed, involves reactions with others, or is a trait of high moral importance (Synonds 1925).

¹⁵ The term “pseudo random” is used to describe a non-random procedure of selecting the terms and scales to be modified. This is not a random procedure, but in the end, it gives the appearance of randomness. The scale order selection procedure involves making sure that no more than three scales with arguably similar terms on the poles are grouped together. The change in scale polarity is done only to scales where the understanding of the scale will not be significantly impacted by the change. The intent is to keep a term that is most likely familiar to the respondent on the left-hand pole of the scale, or the pole of the scale that is most often read first.

¹⁶ If a questionnaire like the proposed were conducted on the general population it is assumed that the non-response bias would have been exceptionally large. Follow-up interviews with several of this study’s participants indicated that if they had not known the researcher they would not have answered the large number of questions.

hypotheses to the research in the hopes that one is statistically supported by the data, a single variant is selected and explored in the decision dimension study.

This approach is consistent with the premise that a third-order problem should be approached with third-order thinking. Good research on third-order problems requires learning and understanding first, and rigorous proof later.¹⁷ The exploratory goal of the decision dimension study is learning and understanding. It is not to trick the data into supporting one of several hypothesized models.

This takes some pressure off the methodology used. Knowing initially that rigorous support for the model is not the goal, data can be collected from a smaller group.¹⁸ Under these conditions, compliance with the assumptions necessary to perform the tests for statistical significance cannot be assured. However, supporting and even more importantly opposing evidence can be generated using some non-statistical analysis tools.

Because of the complexity of the model being proposed, the number of confounding parameters is plausibly vast. When talking about “decision characteristics” or “decision approaches” it is logical to reason that a particular decision’s semantic position is dependent on the current decision set of the individual. For example, today the decision to buy a new car may be perceived to be an important decision but when the lottery awards the individual ten million dollars, it may become trivial. How can these parameters be controlled? The answer is of course that they cannot all be controlled. The hope is that these parameters, if present, would not significantly affect the conclusions of the study. This prospect is much easier to accept when the study explicitly states that the hypotheses are exploratory.

As stated previously, the decision dimension study’s primary objective is to develop a short-list of feasible bipolar semantic scales. The study is limited by this objective. Every attempt is made to design the questionnaire to be consistent with the prior art, presented principally in Snider and Osgood (Snider and Osgood 1969). Questionnaire related parameters; such as the “halo effect,” are addressed by the design. Parameters relating to the target population are left uncontrolled.¹⁹ However, selecting a population with homogeneous membership significantly reduces many of these confounding parameters.

DATA PREPARATION

The following sections detail the data coding and editing procedures. This discussion is followed by a descriptive presentation of the raw results.

Data Coding

The questionnaires are collected and a preliminary verification is made to assure that all pages are returned. The semantic concept scales are prefaced with the letter “Q” and numbered from one to one hundred and three. The semantic evaluation scales are correspondingly numbered with a preface letter “E.” For ease of data entry, the concept scales are then arbitrarily coded from “1” to “7,” with a “1” representing the left-most point and “7” indicating the right-most point. The same procedure is implemented for the evaluation scales, except the coding range is limited to “5” at the right-most point. Any missing data is coded with a “*” and excluded from the data set. An example of this coding process can be seen in Figure 5.

¹⁷ These points were made more explicitly in Scherpereel (2002).

¹⁸ To obtain the data needed to perform many of the statistical factorization procedures, sample sizes on the order of 500-1000 participants would be necessary (Hair, Anderson et al. 1998, p. 99).

¹⁹ No attempt is made to collect additional data that might help stratify the sample, or identify outliers in the population.

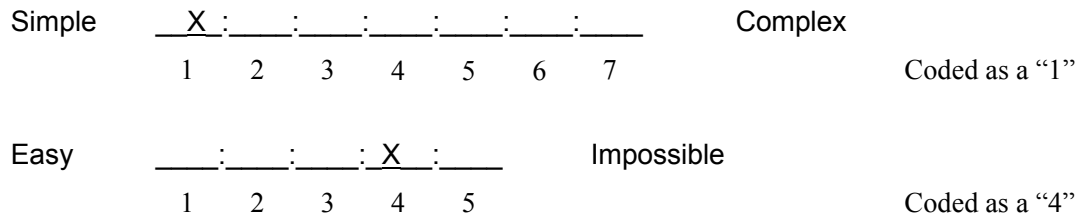


Figure 5: Initial Data Reduction Questionnaire Coding

Once the responses have been coded and rechecked for errors, the polarity of the concept scales that had been reversed in the design process is restored. To ease interpretation, the concept scale results are then normalized to a “-3” to “+3” scale. In this coding structure, a score of “-3” represents one pole, while a score of “+3” represents the opposing pole. The central point on the scale is designated as “0” and represents the neutral position. The evaluation scales are similarly normalized to a “-2” to “+2” scale. Figure 6 illustrates the coding transformation and can be easily compared to the initial coding in Figure 5.

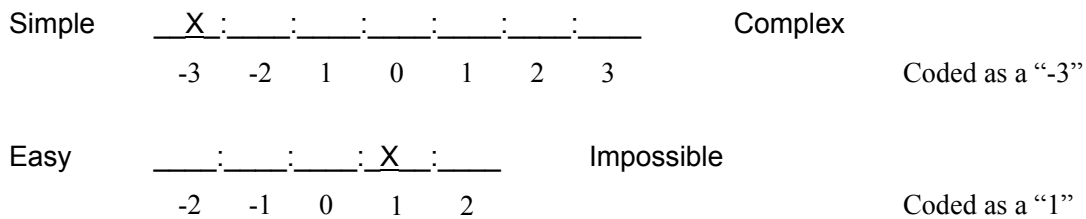


Figure 6: Data Reduction Questionnaire Transformed Coding

Data Editing

Once the data is coded and transformed, questionnaires containing missing or incomplete data are rechecked. The data collected in this study exhibit three types of missing data errors: an unmarked concept scale, an unmarked evaluation scale, or both. The unmarked concept scale with a marked evaluation scale is the most common missing data error. Review of these questionnaires reveals fifty-five (55) occurrences of this omission error. With only a single exception, the evaluations of these scales are marked as difficult to impossible. The decision is made to include the evaluation scores in the data file, even though they do not have a corresponding concept score. This will strengthen the data in most cases, encouraging the concept scale removal from the reduced scale set. In this particular instance the inclusion or exclusion made no difference in the scale selection. The missing concept score is coded as a “*” and effectively reduces the total number of responses to that particular concept.

The second error of omission is a completed concept scale with a missing evaluation scale. This error occurred in four (4) questionnaires. All of these occurrences were associated with very strong, polar scores on the concept scales, which would indicate that the scales were relatively easy to mark.²⁰ Rather than subjectively editing the data to reflect this interpretation, the effect of four omissions is judged to be small and the concept data is included but the response totals for the evaluation scales are reduced.

Finally, the last omission error, where both the concept and evaluation scales are incomplete, occurred five (5) times. A similar assumption can be made that these scales are impossible for the respondents to complete; however, the low level of occurrence creates little concern. Including these data as missing does not materially affect the results. Thus, no subjective editing is done to correct for these errors in the data file. The entire data file remains as originally coded, with missing data coded as a “*” and total responses reduced by the number of missing data items.

²⁰ Osgood et al. (1957) indicated that semantic scales that are more difficult to mark are typically marked toward the neutral position rather than toward the polar ends.

The questionnaires are also inspected to identify any respondents who appeared to mark the scales in an arbitrary manner. Two repeated scales are strategically placed in the questionnaire to check for this error. Examining the responses for a change from one polar direction to the opposite direction checks consistency. The problem is identified on five questionnaires; however, in each instance it only occurs on one of two repeated questions.²¹ Further inspection of these questionnaires does not reveal any abnormal markings that would justify their exclusion from the sample. Therefore, the data is retained in the data set.

RESULTS

Raw Data

The summary results of this study are presented in Table 4 and Table 5. A total of twenty-six (26) questionnaires of the thirty-two (32) distributed were completed and returned, for a response rate of eighty percent. In post questionnaire interviews, respondents indicate that it took approximately 15 minutes to complete all the semantic scales. Although this might be considered a short survey, the interviewees expressed that question fatigue²² is a parameter. This parameter may influence the reliability of responses in later portions of the questionnaire. However, significant increases in non-response error or increases in response variability are not observed. For example, the variability in concept scale number sixty-seven (Q67) is 1.38 while its repeated scale, number one hundred and two (Q102), has approximately the same variability, 1.39. The data collected is judged sufficient for meeting the decision dimension study's objectives.

Scale	Count	Max	Min	Mean	Median	Mode	Standard Deviation
Q1	26	3	-3	-0.19	0.5	1	1.98
Q2	26	3	-1	1.46	2	2	1.36
Q3	25	3	-3	-0.40	-1	-1	1.58
Q4	26	2	-3	-1.35	-1.5	-2	1.23
Q5	25	3	-2	0.48	0	0	1.83
Q6	25	3	-3	0.20	0	0	1.63
Q7	24	3	-2	0.83	0.5	0	1.17
Q8	26	2	-3	-0.54	0	0	1.33
Q9	26	3	-2	2.00	2	3	1.33
Q10	25	2	-3	-0.72	-1	1	1.49
Q11	24	3	-3	1.63	3	3	1.86
Q12	26	3	-3	0.73	1	2	1.69
Q13	25	2	-3	-0.56	-1	-1	1.64
Q14	25	3	-3	0.20	0	0	1.83
Q15	25	3	-3	0.80	1	2	1.66
Q16	23	2	-3	0.00	0	0	1.35
Q17	25	2	-3	-0.36	0	0	1.44
Q18	26	3	-2	0.92	1	2	1.52
Q19	26	2	-3	-1.00	-1.5	-2	1.70
Q20	26	2	-2	-0.19	0	0	1.27
Q21	25	3	-1	1.40	2	2	1.12
Q23	25	3	-3	0.52	0	3	1.92
Q24	25	3	-3	0.08	1	-2	2.02
Q25	26	3	-1	2.58	3	3	0.90
Q26	26	3	-3	-0.50	-1	-1	1.42
Q27	23	3	-3	0.00	0	0	1.51
Q28	24	3	-2	0.21	0	0	1.50
Q29	25	3	0	2.04	2	3	0.98
Q30	26	2	-3	-1.12	-1	-2	1.37
Q31	25	3	-2	0.52	0	0	1.56
Q32	25	3	-3	-0.52	-1	-2	1.90
Q33	23	2	-3	0.13	0	0	1.29
Q34	25	3	-3	0.52	1	0	1.53
Q35	25	3	-2	0.32	1	1	1.60
Q36	26	3	-3	0.46	0	0	1.56
Q37	26	3	-1	1.31	2	2	1.32
Q38	26	3	-3	1.62	2	2	1.42
Q39	26	2	-3	-0.46	0	0	1.70
Q40	26	3	-3	2.08	2	2	1.32
Q41	26	3	-3	0.23	0	3	2.07
Q42	26	3	-3	0.42	0.5	2	1.84
Q43	26	3	-3	0.62	1	2	2.00

Table 4: Decision dimension study – “Decision Characteristic” Raw Data Summary

²¹ The poles on both of the repeated questions are switched in polarity. Therefore, the scales can be considered repeated but not identical. This is done to check if there is a change in interpretation when the scales are reversed. These two effects, consistency in interpretation and consistency in marking, may have compounded to account for the five anomalies. Unfortunately, not enough data is collected to investigate these effects separately, and therefore this is left as an open issue for future research. However, based on the limited sampling, it does not appear that collecting these additional data will significantly affect the results.

²² The term “question fatigue” is used here to describe the respondent’s disinterest in completing the questionnaire and rushing his/her answers because of a large number of questions or repeated tedious questions.

Scale	Count	Max	Min	Mean	Median	Mode	Standard Deviation
Q44	26	3	-3	1.19	1	1	1.39
Q45	26	3	-3	1.77	2	2	1.37
Q46	25	3	-3	0.20	1	2	1.89
Q47	26	2	-3	-0.96	-1	0	1.61
Q48	26	3	-2	0.04	0	-1	1.37
Q49	26	3	-3	-1.12	-2	-3	2.03
Q50	24	3	-2	0.46	0	0	1.59
Q51	26	3	-3	-0.15	0	0	1.52
Q52	26	3	-3	0.50	1	2	1.58
Q53	22	1	-3	-0.73	0	0	1.16
Q54	26	2	-3	-1.88	-2	-2	1.24
Q55	24	1	-3	-0.83	-1	0	1.13
Q56	25	3	-2	1.08	1	2	1.26
Q57	26	3	-2	0.77	1	2	1.70
Q58	23	3	-3	-0.52	0	0	1.59
Q59	26	3	-2	0.85	1.5	2	1.49
Q60	26	3	-3	0.08	0.5	1	1.94
Q61	25	3	-3	1.04	1	2	1.43
Q62	26	3	-3	0.62	1	1	1.83
Q63	25	3	-2	0.64	1	0	1.15
Q64	25	3	-3	0.24	0	0	1.23
Q65	26	3	-3	0.38	1	2	1.81
Q66	26	3	-3	-0.27	0	0	1.80
Q67	26	2	-3	-1.15	-2	-2	1.38
Q68	25	3	-2	0.80	1	0	1.26
Q69	26	2	-2	0.58	1	2	1.36
Q70	26	2	-3	-0.54	-1	-1	1.53
Q71	25	3	-3	-0.36	0	1	1.70
Q72	24	2	-2	-0.29	0	0	1.23
Q73	26	2	-3	-0.12	0	1	1.61
Q74	26	3	-3	0.92	1.5	2	1.76
Q75	26	3	-3	0.12	0	2	1.99
Q76	26	3	-3	-0.15	-1	2	2.09
Q77	26	1	-3	-1.31	-1.5	-2	1.01
Q78	24	3	-3	0.00	0	0	1.72
Q79	26	3	-3	-0.54	-1	-2	1.90
Q80	24	2	-2	0.50	0.5	0	1.22
Q81	26	3	-2	-0.50	-1	-1	1.10
Q82	25	1	-3	-1.20	-2	-2	1.29
Q83	26	2	-3	-1.12	-2	-2	1.42
Q84	24	3	-1	1.54	2	3	1.38
Q85	25	2	-3	-0.04	0	0	1.49
Q86	26	3	-3	0.73	2	2	1.78
Q87	26	1	-3	-1.08	-1	-2	1.29
Q88	26	1	-3	-1.54	-2	-2	1.17
Q89	26	3	-2	0.92	1	1	1.67
Q90	26	3	-3	-1.04	-2	-2	1.87
Q91	25	2	-2	0.00	0	1	1.22
Q92	25	3	-2	0.40	0	1	1.41
Q93	26	3	-2	-1.23	-1.5	-2	1.11
Q94	26	3	-3	0.19	0.5	2	1.67
Q95	26	3	-3	0.35	1	1	1.81
Q96	26	3	-3	-0.12	0	0	1.66
Q97	25	3	-2	-0.16	0	0	1.55
Q98	26	2	-3	-1.58	-2	-2	1.27
Q99	24	3	-2	0.50	0	0	1.35
Q100	26	3	-3	-0.58	-1	-1	1.68
Q101	23	2	-3	0.65	1	2	1.30
Q102	26	2	-3	-1.50	-2	-2	1.39
Q103	25	2	-3	-0.16	0	0	1.52

Table 5: Decision dimension study – “Decision Approach” Raw Data Summary

Data Analysis and Results

Several different techniques are used to explore the data set and to bring forward supporting and opposing information. Some of these techniques are statistically based, including descriptive statistics, correlations, principal component analysis, and common factor analysis. In the next section, the extent to which these techniques are useful will be explored. A more convincing argument is developed for the use of non-statistical techniques. Principal among these non-statistical techniques is cluster analysis. The second section will explore the data set using the cluster analysis techniques. Ultimately, a decision is made to select the semantic scales that best measure the “decision characteristic” and “decision approach” concepts, reducing the number of semantic scales from a total of one hundred and three (103) scales to the actual reduced size of sixteen (16) scales.²³ An investigation of these chosen scales will give insights into the four exploratory hypotheses. The modifications and reasoning will be presented in the concluding sections.

ALTERNATIVE METHODS FOR DATA REDUCTION

A number of methods are recommended for data reduction, and several are employed in this study. The developers of the semantic differential scaling technique, Osgood et al. (1957), introduce the traditional data reduction methodology. It involves the use of common factor analysis to partition the scales into closely related groups. This methodology is based on establishing a correlation between response scales and requires at least as many responses as there are scales. In the case of this study, it would require a minimum of one hundred and three (103) respondents. The literature recommends five to ten times this number (Hair, Anderson et al. 1998, p. 99). Clearly, more data is necessary to implement this procedure. However, the procedure is marginally²⁴ applicable after the data has been reduced to a smaller data set by some other technique.

²³ The target size was originally set at approximately twenty (20) scales; however, the data indicate that only sixteen (16) scales are necessary. Of the sixteen (16) semantic scales, eight (8) measure the “decision characteristic” concept and the remaining eight (8) measure the “decision approach” concept.

²⁴ The term “marginally” applicable is used here, because, even when the data is reduced to maybe nine (9) or (10) selected scales, the number of responses only exceeds the number of scales by three times.

A related methodology that can be implemented is called principal component analysis. There is no mathematical requirement on the number of responses needed, however, research indicates that the technique is unreliable when sample sizes fall below 100 (Hair, Anderson et al. 1998). More damaging is the fact that this technique looks at factors that minimize total variance in the data file and not the variance between factors. The interest in this study is to group factors that are most closely related and most different from other factors. This objective implies that principal component analysis would be inappropriate.

Factorization techniques, common factor analysis, and principal component analysis, each form groups without regard to whether the correlation between variables is positive or negative. Therefore, in factor analytic solutions it is common to have negatively correlated scales appearing in the same factor or grouping. This presents a problem for this study, where the polarity of the scale has intuitive meaning, and placing negatively correlated scales in the same group misses the goal of having most similar scales grouped together. Although these techniques make mathematical sense, the solutions are often intuitively unpalatable.

Ad Hoc Maximum Correlation Methodology

A technique that is pursued in some detail is an ad hoc maximum correlation methodology.²⁵ This methodology inspects the correlation matrix for the most highly correlated semantic differential scales and groups these together. The ad hoc maximum correlation methodology proves useful as a sanity check for the hypothesized theory and provides some guidance in the interpretation of other techniques. Five (5) “decision characteristic” groups are identified using the ad hoc maximum correlation methodology. Table 6 provides a summary of these results.

²⁵ This methodology is not developed formally in the prior art. It is based on the KISS principle, “keep it simple stupid,” and is simply a rational interpretation of the correlation matrix. It is one of the most basic cluster analysis techniques. Cluster analysis is a technique suggested by two biologists, Robert Sokal and Peter Sneath, in a book entitled “Principles of Numerical Taxonomy” (Sokal and Sneath 1963). They argue that an efficient procedure for generating biological classifications would be to gather data on all possible organisms of interest, somehow estimate the degree of similarity among the organisms, and then place similar organisms in the same group, or cluster. Once the groups are identified, the membership can be inspected to determine if they represent the same biological species. Even though the original explanation is stated in biological context, it is a good description of this ad hoc grouping methodology, and provides a good introduction to the formal cluster analysis techniques presented in the next section.

Group 1

[1] Simple - Complex
~~[24] Black and White - Grey~~
~~[10] Constant - Changing~~
~~[30] Defined - Undefined~~
~~[20] Bounded - Unbounded~~

Group 2

[2] Current Focused - Future Focused
[43] Easy - Difficult
~~[3] Predictable - Unpredictable~~
[8] Low Risk - High Risk
[9] Short Term - Long Term
[25] Unimportant - Important
~~[39] Safe - Risky~~
~~[33] Limited - Boundless~~
~~[27] Stagnant - Fluid~~
~~[6] Static - Dynamic~~
~~[7] Repetitive - Varied~~
~~[15] Common - Uncommon~~
~~[18] Low Stakes - High Stakes~~
~~[42] Usual - Unusual~~
~~[21] Common - Unique~~
~~[37] Administrative - Entrepreneurial~~

Group 3

~~[4] Concrete - Abstract~~
[19] Clear - Ambiguous
~~[13] Certain - Uncertain~~
~~[14] Independent - Dependent~~
~~[32] Deterministic - Probabilistic~~
~~[22] Narrow - Broad~~
~~[31] Closed - Open~~
~~[16] Near - Far~~
~~[41] Did not change with time - Changed with time~~

Group 4

~~[5] Revocable - Irrevocable~~
[42] Reversible - Irreversible
~~[28] Restricted - Unrestricted~~
~~[29] Fictional World - Real World~~
~~[11] Frequent - Infrequent~~
~~[35] Many Restrictions - Few Restrictions~~
~~[36] Quantitative - Qualitative~~
~~[26] Constrained - Unconstrained~~

Group 5

~~[17] Quantifiable - Theoretical~~
~~[34] Numerical - Descriptive~~
[40] Small - Big
~~[38] Operational - Strategic~~
~~[23] Could be calculated - Could not be calculated~~

Table 6: Ad Hoc Results for “Decision Characteristic” Concept

Items which have been stricken from Table 6 are those that are judged “too difficult”²⁶ by the study’s participants, while those scales indicated in bold text are evaluated as relatively “simple.” Boxes are indicative of the semantic differential scales that are evaluated as the easiest to mark among the group members.²⁷

The same procedure is used on the “decision approach” concept to identify five (5) unique groups. These groups are presented in Table 7. The same format is used to identify the acceptable scales.

²⁶ Those terms with a mean response on the difficult pole of the semantic scale are identified as “too difficult.”

²⁷ Two boxes appear in the same group when the scales are evaluated as virtually equal in simplicity.

Group 1

- [44] **Textbook - Gut**
- [94] Objective - Subjective
- [72] Deductive - Inductive
- [67] **Organized - Disorganized**
- [71] Optimal - Satisfactory
- [47] Find a Best solution - Find a Usable solution
- [102] Organized - Disorganized
- [70] Complete - Incomplete
- [82] Evidential - Circumstantial
- [66] Research - Intuition
- [98] **Active Search - Passive Search**

Group 2

- [92] Dictatorial - Democratic
- [49] **Individual - Team**
- [95] **Isolated - Collaborative**
- [80] Disconnected - Connected
- [52] Formal - Informal
- [53] Convergent - Divergent
- [103] Independent - Dependent
- [87] Whole - Partial
- [54] **Deliberate - Accidental**
- [79] Select from Alternatives - Search for Alternatives
- [65] Only Complete solutions ... - Partial solutions ...
- [63] Imitation - Innovation
- [85] Filtering - Generative

Group 3

- [46] **Quick - Slow**
- [57] Fast - Slow
- [59] **Effortless - Laborious**
- [62] **Unemotional - Emotional**
- [75] **Easy - Difficult**
- [89] **Relaxed - Stressed**
- [84] Over-Lunch - Over-Night

Group 4

- [60] Exact - Approximate
- [73] Exact - Approximate
- [91] Saving - Gambling
- [61] **Risk Avoiding - Risk Taking**
- [74] **Detailed - Big Picture**
- [104] Efficient - Effective
- [68] Closed - Open
- [76] ... Single solution - ... Many solutions
- [69] Risk Averse - Risk Preferring
- [86] Risk Avoiding - Risk Accepting

Group 5

- [55] Explicit - Implicit
- [88] **Methodical - Haphazard**
- [93] Procedural - Ad Hoc
- [83] **Systematic - Unsystematic**
- [96] Fact Driven - Opinion Driven
- [64] Old Method - New Method
- [78] Calculation - Experimentation
- [45] **Computer Driven - Human Driven**
- [56] Mathematics - Experience
- [90] **Planned - Unplanned**
- [58] Anal - Willy-Nilly
- [51] Sophisticated - Unsophisticated
- [99] Provable - Usable
- [81] **Leisurely - Hasty**
- [48] Efficient - Inefficient
- [97] Tangible - Intangible
- [77] Effective - Ineffective
- [100] **Unhurried - Hurried**
- [50] Valid - Practical

Table 7: Ad Hoc Results for “Decision Approach” Concept

Labeling the groups identified in Table 6 and Table 7 might suggest a five dimensional semantic space for both the “decision characteristic” and the “decision approach” concepts. The inferred multidimensional space is illustrated in Figure 7.

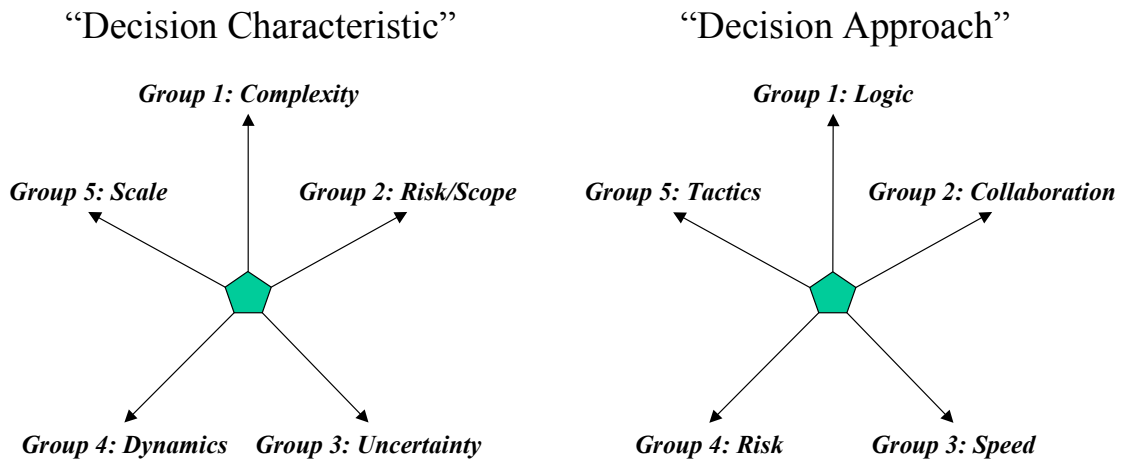


Figure 7: Ad Hoc Five Dimensional Semantic Spaces

The next section extends this technique with more rigorously developed clustering procedures.

Cluster Analytic Results

Given the relatively small sample size and the desire to group only positively correlated variables, cluster analysis emerges as the preferred methodology. Although most commonly used to find groupings of responses, it has proven useful in finding groupings of variables, and in this case grouping of semantic scales. There are a number of methods available.²⁸ The most familiar is based on one of several hierarchical algorithms. The four most common algorithms are single, complete, average, and Ward linkages. These are all described in the common literature, however, only the Ward-linkage results are detailed in this section since this algorithm is judged to perform “best” on the given data file.

A cluster analysis procedure is first performed on the “decision characteristic” concept. At each stage of the clustering procedure, individual variables are fused to other variables that are most “similar.”²⁹ The end product of the clustering procedure is a dendrogram, showing the successive fusion of variables into clusters. The final stage represents the combination of all variables into a single group or cluster. Figure 8 shows the dendrogram for the “decision characteristic” concept using the Ward-linkage clustering algorithm. Two lines are drawn to indicate where a three and five-cluster partition would be made.

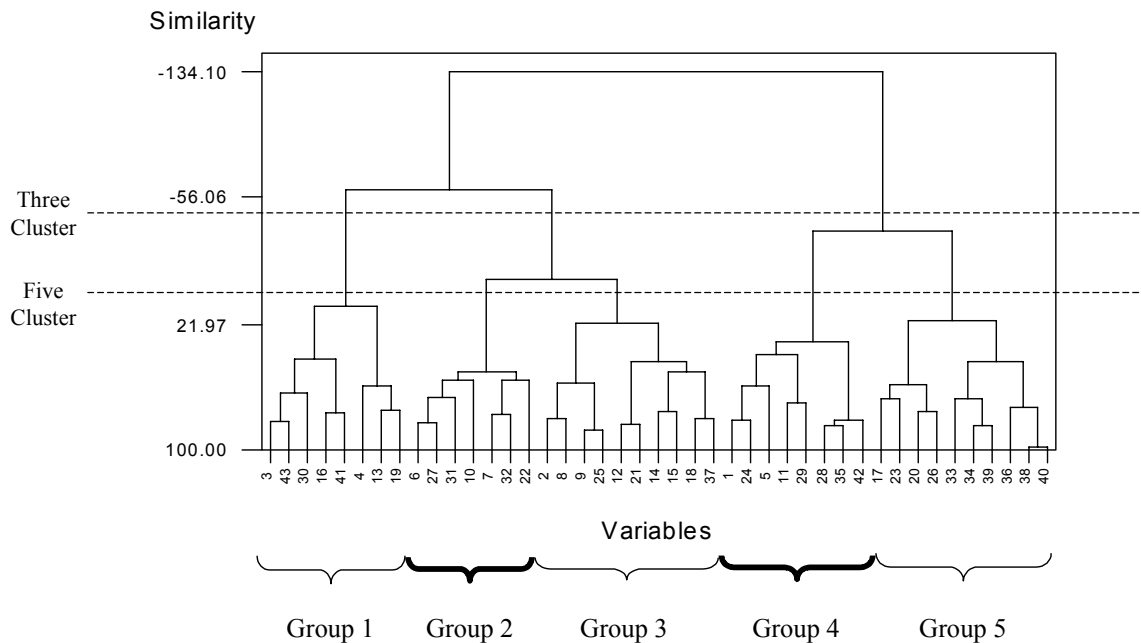


Figure 8: Ward Dendrogram for the “Decision Characteristic” Concept

²⁸ These methods include the following: (1) Hierarchical techniques – In which the clusters are formed by finding the most efficient linkages, linking the “closest” variables (“closest” is defined by the algorithm), at each successive step in the algorithm. (2) Optimization-partitioning techniques – In which clusters are formed by the optimization of a “clustering criterion.” (3) Density or mode-seeking techniques – Where clusters are formulated by finding the regions which contain concentrations of variables. (4) Clumping techniques – In which the groups, or clumps formed, can overlap. (5) Others (Everitt 1974, p. 7).

²⁹ Differences between the hierarchical cluster methods arise because there are different ways to define “similarity” between an individual variable and a reference group containing one or more variables. “Similarity” is usually defined as some distance measure.

The group identifications below the dendrogram, Figure 8, correspond to the groups of semantic differential scales in Table 8. As before, items that have been stricken are those that were evaluated as “too difficult,” while those in bold text were considered relatively simple. The boxed items are those scales that were evaluated as the easiest within a specific group.

<p>Group 1</p> <hr/> <p>[3] Predictable - Unpredictable [43] Easy - Difficult [30] Defined - Undefined [16] Near - Far [41] Did not change with time - Changed with time [4] Concrete - Abstract [13] Certain - Uncertain [19] Clear - Ambiguous</p>	<p>Group 4</p> <hr/> <p>[1] Simple - Complex [24] Black and White - Grey [5] Revocable - Irrevocable [11] Frequent - Infrequent [29] Fictional World - Real World [28] Restricted - Unrestricted [35] Many Restrictions - Few Restrictions [42] Reversible - Irreversible</p>
<p>Group 2</p> <hr/> <p>[6] Static - Dynamic [27] Stagnant - Fluid [31] Closed - Open [10] Constant - Changing [7] Repetitive - Varied [32] Deterministic - Probabilistic [22] Narrow - Broad</p>	<p>Group 5</p> <hr/> <p>[17] Quantifiable - Theoretical [23] Could be calculated - Could not be calculated [20] Bounded - Unbounded [26] Constrained - Unconstrained [33] Limited - Boundless [34] Numerical - Descriptive [39] Safe - Risky [36] Quantitative - Qualitative [38] Operational - Strategic [40] Small - Big</p>
<p>Group 3</p> <hr/> <p>[2] Current Focused - Future Focused [8] Low Risk - High Risk [9] Short Term - Long Term [25] Unimportant - Important [12] Usual - Unusual [21] Common - Unique [14] Independent - Dependent [15] Common - Uncommon [18] Low Stakes - High Stakes [37] Administrative - Entrepreneurial</p>	

Table 8: Ward Groupings for the “Decision Characteristic” Concept

Because the cluster analysis technique is sensitive to the variables included, the Ward linkage algorithm is reapplied after the “too difficult” scales have been removed. The new dendrogram is illustrated in Figure 9.

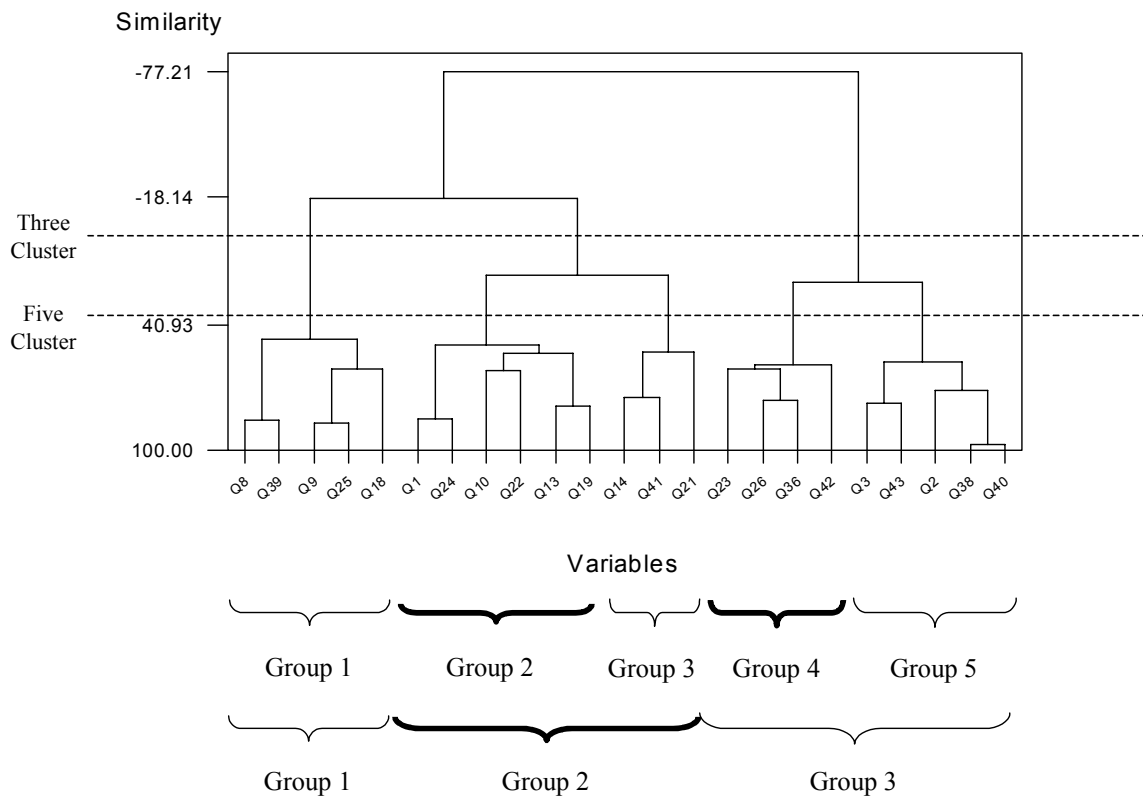


Figure 9: Ward Dendrogram for the Reduced “Decision Characteristic” Concept

This dendrogram suggests five distinct groups are possible, however, it also provides support for a three-cluster solution. Both these groupings are listed in Table 9. The items highlighted in bold were evaluated as “simple.” The simplest among the items in a group are boxed.

3 Cluster Solution

Group 1
[8] Low Risk - High Risk
[39] Safe - Risky
[9] Short Term - Long Term
[25] Unimportant - Important
[18] Low Stakes - High Stakes
Group 2
[1] Simple - Complex
[24] Black and White - Grey
[10] Constant - Changing
[22] Narrow - Broad
[13] Certain - Uncertain
[19] Clear - Ambiguous
[14] Independent - Dependent
[41] Did not change with time - Changed with time
[21] Common - Unique
Group 3
[23] Could be calculated - Could not be calculated
[26] Constrained - Unconstrained
[36] Quantitative - Qualitative
[42] Reversible - Irreversible
[3] Predictable - Unpredictable
[43] Easy - Difficult
[2] Current Focused - Future Focused
[38] Operational - Strategic
[40] Small - Big

5 Cluster Solution

Group 1
[8] Low Risk - High Risk
[39] Safe - Risky
[9] Short Term - Long Term
[25] Unimportant - Important
[18] Low Stakes - High Stakes
Group 2
[1] Simple - Complex
[24] Black and White - Grey
[10] Constant - Changing
[22] Narrow - Broad
[13] Certain - Uncertain
[19] Clear - Ambiguous
Group 3
[14] Independent - Dependent
[41] Did not change with time - Changed with time
[21] Common - Unique
Group 4
[23] Could be calculated - Could not be calculated
[26] Constrained - Unconstrained
[36] Quantitative - Qualitative
[42] Reversible - Irreversible
Group 5
[3] Predictable - Unpredictable
[43] Easy - Difficult
[2] Current Focused - Future Focused
[38] Operational - Strategic
[40] Small - Big

Table 9: Ward Groupings for the Reduced “Decision Characteristic” Concept

The same clustering procedure is used for the “decision approach” concept. A clustering of all sixty “decision approach” semantic differential scales results in the Figure 10 dendrogram.

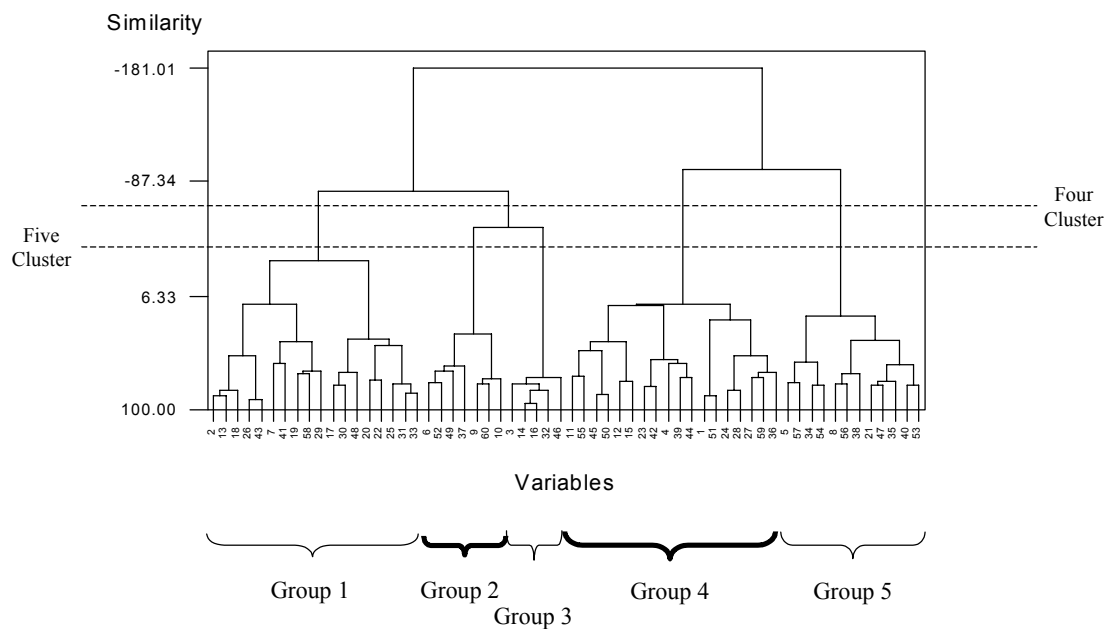


Figure 10: Ward Dendrogram for the “Decision Approach” Concept

A five-cluster solution can be selected from the dendrogram. Since this is consistent with the exploratory hypothesis proposed for the “decision approach” concept, five groups are extracted from the dendrogram and sited in Figure 10. As previously formatted, “too difficult” scales are stricken, “simple” scales are in bold, and the simplest in each group is boxed.

Group 1**[45] Computer Driven - Human Driven**~~[56] Mathematics - Experience~~**[61] Risk Avoiding - Risk Taking**

[69] Risk Averse - Risk Preferring

[86] Risk Avoiding - Risk Accepting

[50] Valid - Practical

~~[84] Over Lunch - Over Night~~**[62] Unemotional - Emotional**~~[101] Efficient - Effective~~

[72] Deductive - Inductive

[60] Exact - Approximate

[73] Exact - Approximate

~~[91] Saving - Gambling~~~~[63] Imitation - Innovation~~

[65] Only Complete solutions ... - Partial solutions ...

~~[68] Closed - Open~~**[74] Detailed - Big Picture**

[76] Search for a Single solution - Search for Many solutions

Group 2**[49] Individual - Team****[95] Isolated - Collaborative**~~[92] Dictatorial - Democratic~~~~[80] Disconnected - Connected~~

[52] Formal - Informal

~~[103] Independent - Dependent~~~~[53] Convergent - Divergent~~**Group 3****[46] Quick - Slow**

[57] Fast - Slow

[59] Effortless - Laborious**[75] Easy - Difficult****[89] Relaxed - Stressed****Group 4****[54] Deliberate - Accidental****[98] Active Search - Passive Search****[88] Methodical - Haphazard**

[93] Procedural - Ad Hoc

~~[55] Explicit - Implicit~~~~[58] Anal - Willy Nilly~~

[66] Research - Intuition

~~[85] Filtering - Generative~~

[47] Find a Best solution - Find a Usable solution

~~[82] Evidential - Circumstantial~~

[87] Whole - Partial

[44] Textbook - Gut

[94] Objective - Subjective

[67] Organized - Disorganized

[71] Optimal - Satisfactory

[70] Complete - Incomplete

[102] Organized - Disorganized

[79] Select from Alternatives - Search for Alternatives

Group 5

[48] Efficient - Inefficient

[100] Unhurried - Hurried

[77] Effective - Ineffective

[97] Tangible - Intangible

[51] Sophisticated - Unsophisticated

[99] Provable - Usable

[81] Leisurely - Hasty~~[64] Old Method - New Method~~**[90] Planned - Unplanned**~~[78] Calculation - Experimentation~~**[83] Systematic - Unsystematic**

[96] Fact Driven - Opinion Driven

Table 10: Ward Groupings for the "Decision Approach" Concept

Since the data suggests the removal of scales stricken from Table 10, the Ward linkage algorithm is reapplied. Figure 11 contains the new dendrogram that can be partitioned into five groups. This figure also suggests a clearly demarcated four-cluster solution.

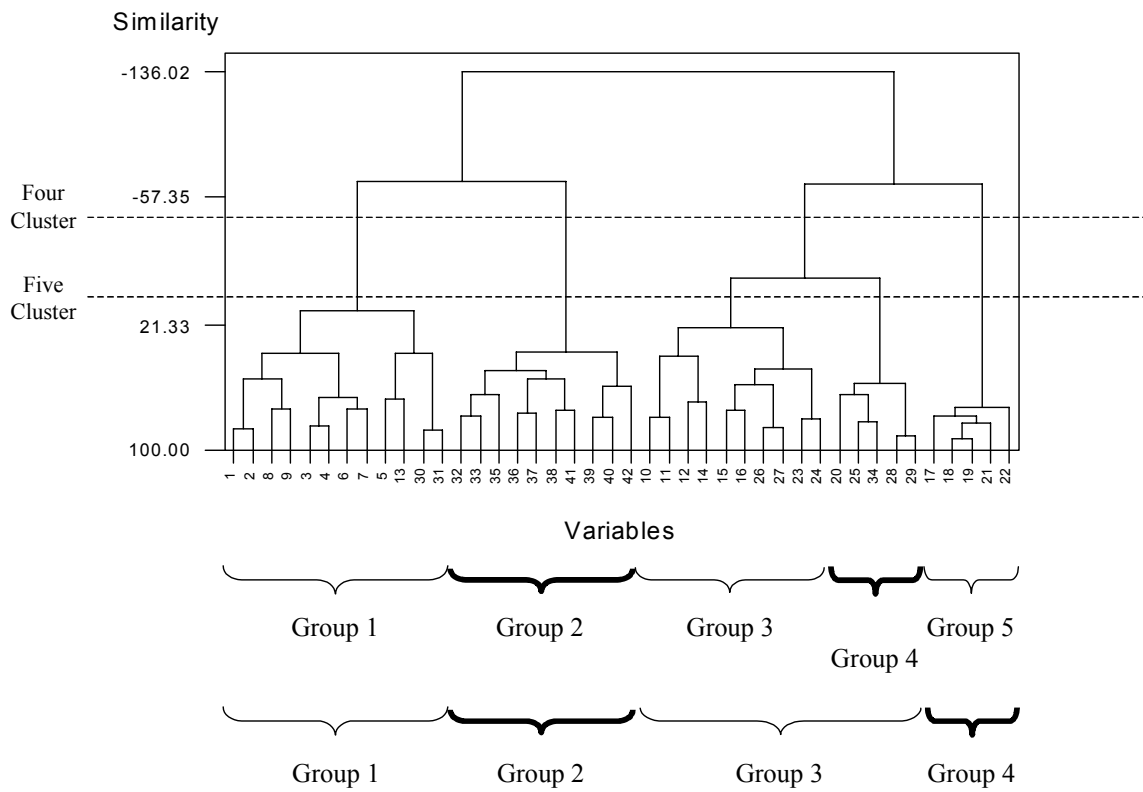


Figure 11: Ward Dendrogram for the Reduced “Decision Approach” Concept

Both of these feasible solutions are tabulated in Table 11.

4 Cluster Solution

Group 1
[44] Textbook - Gut
[94] Objective - Subjective
[67] Organized - Disorganized
[71] Optimal - Satisfactory
[47] Find a Best solution - Find a Usable solution
[102] Organized - Disorganized
[70] Complete - Incomplete
[66] Research - Intuition
[98] Active Search - Passive Search
[87] Whole - Partial
[88] Methodical - Haphazard
[93] Procedural - Ad Hoc
Group 2
[83] Systematic - Unsystematic
[96] Fact Driven - Opinion Driven
[90] Planned - Unplanned
[51] Sophisticated - Unsophisticated
[81] Leisurely - Hasty
[48] Efficient - Inefficient
[97] Tangible - Intangible
[77] Effective - Ineffective
[100] Unhurried - Hurried
[50] Valid - Practical
Group 3
[62] Unemotional - Emotional
[61] Risk Avoiding - Risk Taking
[69] Risk Averse - Risk Preferring
[86] Risk Avoiding - Risk Accepting
[45] Computer Driven - Human Driven
[49] Individual - Team
[95] Isolated - Collaborative
[52] Formal - Informal
[54] Deliberate - Accidental
[79] Select from Alternatives - Search for Alternatives
[65] Only Complete solutions ... - Partial solutions ...
[60] Exact - Approximate
[73] Exact - Approximate
[74] Detailed - Big Picture
[76] Search for a Single solution - Search for Many solutions
Group 4
[46] Quick - Slow
[57] Fast - Slow
[59] Effortless - Laborious
[75] Easy - Difficult
[89] Relaxed - Stressed

5 Cluster Solution

Group 1
[44] Textbook - Gut
[94] Objective - Subjective
[67] Organized - Disorganized
[71] Optimal - Satisfactory
[47] Find a Best solution - Find a Usable solution
[102] Organized - Disorganized
[70] Complete - Incomplete
[66] Research - Intuition
[98] Active Search - Passive Search
[87] Whole - Partial
[88] Methodical - Haphazard
[93] Procedural - Ad Hoc
Group 2
[83] Systematic - Unsystematic
[96] Fact Driven - Opinion Driven
[90] Planned - Unplanned
[51] Sophisticated - Unsophisticated
[81] Leisurely - Hasty
[48] Efficient - Inefficient
[97] Tangible - Intangible
[77] Effective - Ineffective
[100] Unhurried - Hurried
[50] Valid - Practical
Group 3
[49] Individual - Team
[95] Isolated - Collaborative
[52] Formal - Informal
[54] Deliberate - Accidental
[79] Select from Alternatives - Search for Alternatives
[65] Only Complete solutions ... - Partial solutions ...
[60] Exact - Approximate
[73] Exact - Approximate
[74] Detailed - Big Picture
[76] Search for a Single solution - Search for Many solutions
Group 4
[62] Unemotional - Emotional
[61] Risk Avoiding - Risk Taking
[69] Risk Averse - Risk Preferring
[86] Risk Avoiding - Risk Accepting
[45] Computer Driven - Human Driven
Group 5
[46] Quick - Slow
[57] Fast - Slow
[59] Effortless - Laborious
[75] Easy - Difficult
[89] Relaxed - Stressed

Table 11: Ward Groupings for the Reduced “Decision Approach” Concept

In summary, the Ward-linkage clustering algorithm identifies a number of potential clusters that exist in the data. Since these clusters are groups of semantic scales, they suggest a multidimensional space for both the “decision characteristic” and “decision approach” concepts. The exploratory hypothesis stated that there are five dimensions in the semantic space for both concepts; therefore, five groups are extracted from the clustering procedure. Based on the group makeup identified in Table 9 and Table 11, the five dimensional semantic spaces are illustrated and labeled in Figure 12.

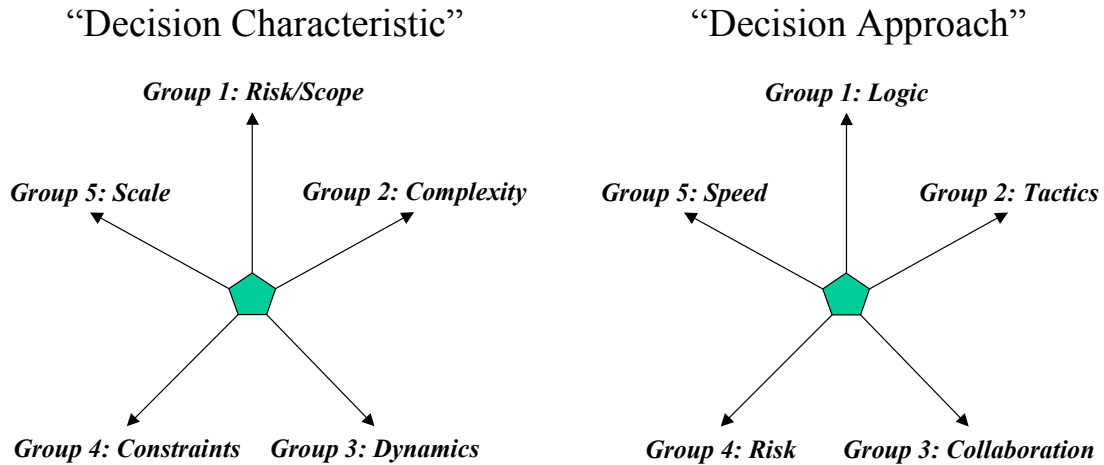


Figure 12: Cluster Analytic Five Dimensional Semantic Space

However, this procedure also identified the possibility of a reduced semantic space for both concepts. For the “decision characteristic” concept a three-dimensional space is identified in Table 9, while the “decision approach” concept Table 11 identifies a four-dimensional space as justifiable. These alternative models are depicted and labeled in Figure 13.

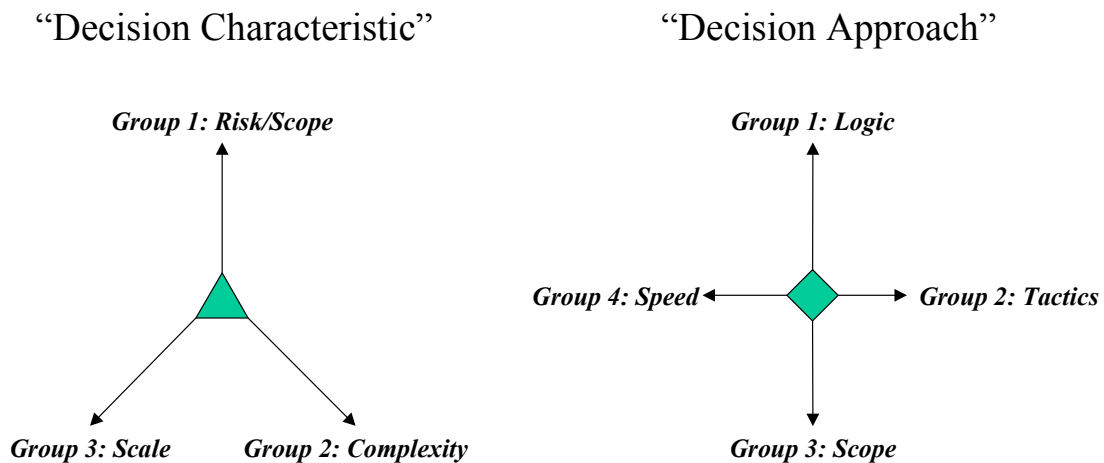


Figure 13: Cluster Analytic Three and Four Dimensional Semantic Spaces

DECISION DIMENSION STUDY DISCUSSION AND CONCLUSIONS

The decision dimension study results point toward several alternatives in the selection of a short-list of feasible bipolar semantic scales. In the first section that follows, these alternatives are explored. Using several criteria, including: respondent evaluations, analytical groupings, and “Occam’s Razor,”³⁰ a final selection is completed.

³⁰ The principle known as “Occam’s Razor” arose from the writings of Franciscan philosopher and theologian William of Occam. Occam espoused the Aristotelian view that circumstances must not be multiplied beyond what is necessary. The principle that bears his name states that “plurality should not be posited without necessity” or in common usage, if there are two ways to explain something choose the simpler.

The decision dimension study also provides supporting evidence for reexamining, refining, and reformulating the four exploratory hypotheses. The second section highlights this evidence, and attempts to craft an improved theory. These results suggest that empirical validation is possible and builds the foundation for future research. Final thoughts and future directions are presented in the last section.

SEMANTIC SCALE SELECTION

The principal objective of the decision dimension study is to construct a short-list of semantic differential scales that can be used as proxy measures for multiple dimensions of decision-making. In previous sections, several analytical techniques are utilized to prune the initial list of semantic differential scales, first presented in Table 1. This pruning process results in several alternative hypothetical models: Figure 7, Figure 12, and Figure 13. Analyzing these models, the most representative semantic differential scales are selected from their respective data tables. The selection process imposes five constraints:

- 1) a target of two or more proxy scales per dimension measured
- 2) a maximum of ten (10) scales describing the entire semantic space
- 3) an evaluation below the “too difficult” threshold
- 4) selecting the scale evaluated “simplest” amongst the group
- 5) selecting a scale identified as “different”³¹ from the “simplest” within a single group

The short-lists derived from this scale selection process incorporate the “best” proxy scales for measuring the concept dimensions of interest. They are summarized in Table 12 for convenience. The theory modification discussion in the next section will suggest which of these groupings are more appropriate for future research.

³¹ The meaning of the term “different” depends on the technique used. In the ad hoc maximum correlation methodology, the term “different” implies that a scale is selected based on subjective post-questionnaire interviews and subjective evaluation by the researcher. In the cluster analysis methodology, the dendrograms provide some information regarding scale difference; thus, this selection can be considered to have greater objectivity. However, in all cases a subjective bias on the part of the researcher is used in final arbitration.

"Decision Characteristic" Concept			
Dimension	Ad Hoc 5-groups	Cluster 5 Groups	Cluster 3-groups
Complexity	[1] Simple - Complex [10] Constant - Changing	[1] Simple - Complex [19] Clear - Ambiguous	[1] Simple - Complex [19] Clear - Ambiguous [10] Constant - Changing
Risk/Scope	[9] Short Term - Long Term [25] Unimportant - Important	[9] Short Term - Long Term [8] Low Risk - High Risk	[9] Short Term - Long Term [8] Low Risk - High Risk [25] Unimportant - Important
Uncertainty	[19] Clear - Ambiguous [22] Narrow - Broad		
Dynamics	[42] Reversible - Irreversible [26] Constrained - Unconstrained	[42] Reversible - Irreversible [26] Constrained - Unconstrained	
Scale	[40] Small - Big [38] Operational - Strategic	[40] Small - Big [3] Predictable - Unpredictable	[40] Small - Big [42] Reversible - Irreversible [26] Constrained - Unconstrained
Constraints		[41] Did not change with time - Changed with time [21] Common - Unique	

"Decision Approach" Concept			
Dimension	Ad Hoc 5-groups	Cluster 5 Groups	Cluster 4-groups
Logic	[44] Textbook - Gut [98] Active Search - Passive Search	[88] Methodical - Haphazard [44] Textbook - Gut	[88] Methodical - Haphazard [44] Textbook - Gut [98] Active Search - Passive Search
Collaboration	[49] Individual - Team [54] Deliberate - Accidental	[49] Individual - Team [74] Detailed - Big Picture	
Speed	[89] Relaxed - Stressed [46] Quick - Slow	[89] Relaxed - Stressed [46] Quick - Slow	[89] Relaxed - Stressed [46] Quick - Slow
Risk	[61] Risk Avoiding - Risk Taking [74] Detailed - Big Picture	[45] Computer Driven - Human Driven [61] Risk Avoiding - Risk Taking	
Tactics	[90] Planned - Unplanned [88] Methodical - Haphazard	[90] Planned - Unplanned [100] Unhurried - Hurried	[90] Planned - Unplanned [100] Unhurried - Hurried
Scope			[49] Individual - Team [74] Detailed - Big Picture [61] Risk Avoiding - Risk Taking

Table 12: Short-list Summary

Theory Modification

The short-lists developed in the previous section provide some supporting evidence for the original five-dimensional models depicted in Figure 2 and Figure 3. A five dimensional solution is found using both the ad hoc and the cluster methodologies. These solutions roughly mirror the original groupings, however there are some significant differences. In hypothesis H1, represented by the five-dimensional “decision characteristic” model in Figure 2, the distinction is made between the “risk,” “scope,” and “time” dimensions. The empirical evidence does not support this same distinction. In fact, all three dimensions have a component that combine to form a unique dimension labeled “risk/scope” to emphasize the horizon risk relationship.³² From the remaining components, emerge the “scale” dimension associated with the size of the decision, and the “dynamics” dimension relating to the characteristics of the decision structure.

Another significant difference is seen in examining the hypothetical five-dimensional “decision approach” model, hypothesis H3 shown in Figure 3. The empirical evidence indicates that the “time” dimension might be better described as a “speed” dimension to evoke its more actionable quality. The original “scope” dimension is no longer obvious in the empirical five-dimensional models; instead, an intuitively appealing “tactics” dimension, which focuses on the decision process, replaces it. However, in the four-dimensional formulation, the “scope” dimension reemerges to direct attention to the vastness rather than the limits of the decision.

³² The horizon risk relationship relates to the concept that decisions further out on the time horizon have greater risk. For example, the yield on equally rated short-term bonds is typically lower than the yield on long term bonds.

Although the models differ, they share the common theme of multidimensionality. Since the data did not reproduce the original dimensional representations, the hypotheses regarding the appropriate proxy measures, labeled H2 and H4, cannot be confirmed. However, the evidence does indicate that certain scales from each of these groupings are suitable proxy scales for the empirically developed models, and as the following model modification indicates, at least one measurement scale from this original theoretical model is included in the final formulation.

Applying “Occam’s Razor,” the simplest multidimensional formulation that captures the essence of the “decision characteristic” concept and provides an intuitively appealing solution is a modified three-dimensional semantic space. This space is a modification of the three-dimensional cluster analytic solution. After review of the evaluation data, it is decided that the constrained-unconstrained scale should be dropped, since several respondents indicated that it is “impossible” to mark. Comparing the scales included in this final model, Figure 14, with those in the original hypothetical model, Table 2, it is noted that at least one scale from each of the original five dimensions is included in the three-dimension solution. This suggests that the final solution for the “decision characteristic” concept may be a hierarchical predecessor to the original hypothesis.

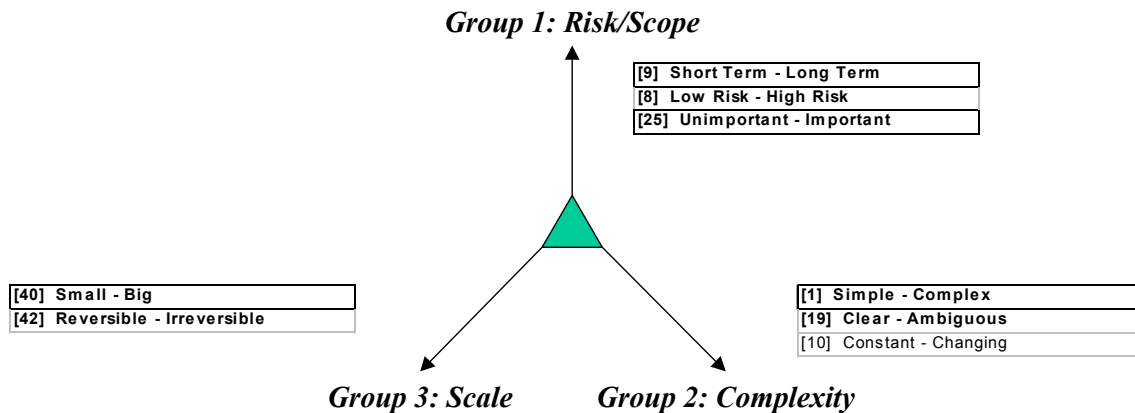


Figure 14: Modified Three-Dimensional “Decision Characteristic” Semantic Space

Interestingly, the same supporting evidence is generated by the “decision approach” concept analysis. Selecting the simplest reasonable multidimensional formulation, a modified four-dimensional semantic space is recommended. Looking at each proxy scale suggested for this model, two modifications are made. The first removes the relaxed-stressed semantic scale from the model. The decision dimension study respondents evaluate this scale as “simple.” Unfortunately in this study, the decision target³³ is presented in a past tense form. It is relatively easy for someone to recall a past decision and evaluate whether or not the approach was “stressed.” If the decision target is presented in a present or future tense form, the scale will likely become more difficult. It is much more difficult to determine the type of approach needed for a particular decision to be made sometime in the future. Does the decision need a “stressed” or “relaxed” approach? Since the relaxed-stressed semantic scale elicits more of a personal assessment of the respondent’s past rather than an assessment of the decision concept itself, the scale is dropped as a proxy measure.

The second modification is the elimination of the semantic scale unhurried-hurried. This scale is eliminated because it appears redundant when placed next to the scale planned-unplanned in the four-dimensional model. Therefore the final formulation of the “decision approach” concept includes only eight (8) semantic scales and is depicted in Figure 15. Again at least one scale in each of the original hypothesized groupings, Table 3, can be found in this proposed semantic space. Thus, some support can be generated for the idea that the proposed solution is a hierarchical predecessor to the original hypothesis. Although this does not validate, in a statistical sense, the original hypothesis, it does suggest that original conceptualization is valid and that further research in this area might be fruitful.

³³ The decision target is the specific decision referred to by the decision concept. For example, the decision concept may be the “decision characteristic” and refer to the decision target “buying a new car.”

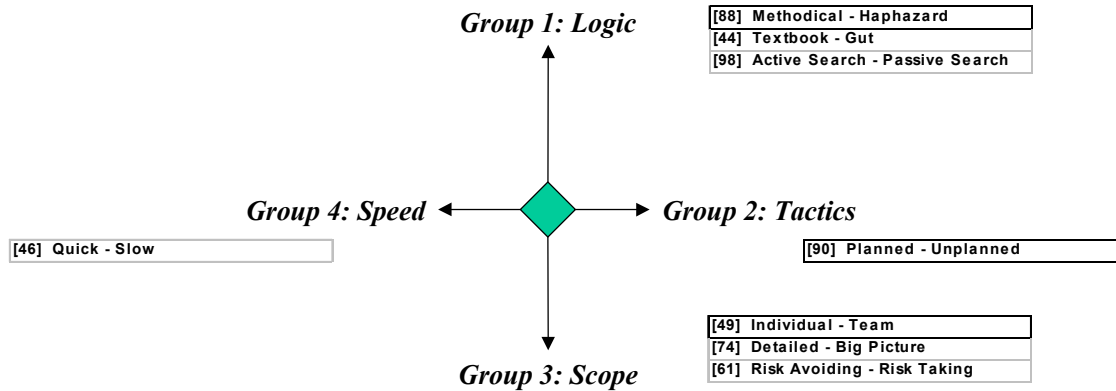


Figure 15: Modified Four-Dimensional “Decision Approach” Semantic Space

CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

The objective of this study is to construct a short-list of semantic scales to be used for future testing. This objective is achieved in Figure 14 and Figure 15. A fair amount of confidence can be placed in the selection of the included scales being “good” proxy” measures for the concepts of interest, the “decision characteristic” and “decision approach” concepts. However, the labeling and the grouping of these semantic dimensions can be proposed with much less confidence. The data indicate that the dimensions overlap,³⁴ which implies that the same proxy scale can be an indicator on one, two, or even more dimensions. If the proxy scales are not unique, as the data suggest, the solution methodologies used may group them differently each time a concept is tested, and particularly when a new concept is tested. Further testing of the semantic space for stability should alleviate this concern and allow for better labeling of the semantic dimensions.

Perhaps future research will validate the proposed dimensions without modification. More likely, however, the research will extend the interpretation with some important refinements. Only a single decision target was used in developing these models. The intentional pruning of the number of semantic differential scales, representing the semantic space, allows multiple targets to be tested on the same group. This major reduction eliminates some of the concern with respondent fatigue, which was experienced in the decision dimension study. Thus, using this reduced proxy set, a future study will be able to test these proposed models on a single respondent group using a variety of decision targets.

³⁴ The possible overlapping of groups of proxy scales is evidenced by several of the alternative clustering methods.

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