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ABSTRACT

Past studies suggested that decision support systems (DSS) must be an "enabling" system aiming to enhance users' capabilities and to leverage their skills and intelligence. This suggests that users be the center of DSS and users' characteristics be an important factor of explaining their DSS acceptance behavior. Since DSS are aimed to work in semi-structured and unstructured task environment, perceived task complexity can be used to explain users' willingness to accept DSS. Further, several studies also used decision models for investigating users' DSS acceptance behavior. We argue that nature of DSS (based on their underlying decision models) and its interaction with individual differences also play important roles on users' DSS acceptance behavior. With the conjecture that users' DSS acceptance behavior directly affects the DSS usage and DSS success, our research question focuses on how do individual differences influence users' DSS acceptance behavior with consideration of task characteristics and nature of the DSS. The contribution of this paper is multifold. First, we extend the existing understanding of effects of individual differences on users' DSS acceptance behavior. Second, we extend two major measurements of cognitive styles (GEFT - Group Embedded Figures Test and MBTI - Myers-Briggs Type Indicator) for individual differences in the context of DSS. Third, we investigate multiple task complexities and multiple DSS models. Hypotheses are developed and will be tested with an experiment of 300 plus subjects.

Keywords

Individual differences, task, decision model, user acceptance, decision support systems

INTRODUCTION

Empirical evidence indicates that organizations have heavily invested in information technology (IT) (Brynjolfsson 1996; Chau et al. 2002); however, early studies have showed that a user's willingness to accept and use IT often obstructs potential gains of such investments (Bowen 1986; Davis 1989; Young 1984). Specifically in decision support systems (DSS) area, millions of dollars have been invested in developing DSS that have never been used (Cheney et al. 1982; Fuerst et al. 1982; Lu et al. 2001). Therefore, we conjecture that one key to successful DSS lies heavily on users' acceptance of DSS which is worth more attention. Surprisingly, according to a meta-analysis for technology acceptance model (TAM) literature from 1986 to 2003 (Lee et al. 2003), there are only two studies related to DSS (Lu et al. 2001; Lu et al. 1994). In this study, we propose to investigate how task characteristics, individual differences, and nature of DSS affect users' acceptance of DSS.

DSS are mostly involved in semi-structured and unstructured *task* environments. The ambiguity of such task environments significantly constrains decision makers' ability to pursue efficiency. On the other hand, the role of DSS as supporting rather than replacing a decision maker indicates that DSS should be *user*-oriented. While this characteristic implies that DSS must be an "enabling" system aiming to enhance users' capabilities and to leverage their skills and intelligence (Adler et al. 1996), it also suggests that users' characteristics be an important factor of explaining their DSS acceptance behavior. Several past studies used *decision models* for investigating users' DSS acceptance behavior (Lu et al. 2001). We argue that nature of DSS (based on their underlying decision models) and its interaction with individual differences also play important roles on users' DSS acceptance behavior.

In order to make more sense of users' DSS acceptance behavior induced by relevant and important three factors mentioned above, we propose to examine this problem from the perspective of a technological frame (Orlikowski et al. 1994) rather than from isolated factors. Using this approach can help us understand users' DSS acceptance

behavior from a holistic view and make more sense of factors proposed in Theory of Reasoned Action (TRA) (Fishbein et al. 1975), TAM (Davis 1989), and Task-Technology Fit (TTF) (Goodhue et al. 1995). Further, in order for us to capture the nuance of individual differences from the importance and prevalence of cognitive style research, we include two major measurements of cognitive style, Group Embedded Figures Test (GEFT) (Witkin et al. 1971) and Myers-Briggs Type Indicator (MBTI) (Myers et al. 1985), in our experiment. With the conjecture that users' DSS acceptance behavior directly affects the DSS usage and DSS success, our research question focuses on *how individual differences influence user's acceptance behavior with consideration of task characteristics and nature of the DSS*.

The contribution of this paper is multifold. First, we extend the existing understanding of effects of individual differences on users' DSS acceptance behavior. Especially, we treat individual difference not just as a sole influencing factor of a user's behavior, but an interdependent factor that interact with both task characteristics and DSS nature. In addition, we distinguish perceived task complexity from objective task complexity so that the effects of individual differences on task characteristics can be captured. We also treat a user's appreciation of task and DSS as two separable processes. The purpose to do so is to examine the direct effects of individual differences on perceived task complexity and nature of DSS.

Second, we extend two major measurements of cognitive styles in specific context of DSS. Cognitive style is believed to be a fundamental factor for IS success (Lucas 1973; Mason et al. 1973; Zmud 1979) and inspires a great lot of research (Ramaprasad 1987). But the diversity of cognitive style measurements causes significant difficulties to compare different studies. A meta-analysis research (Alavi et al. 1992) shows that the use of different measurement is related to the effect size of cognitive style on DSS performance. To understand the existing studies with different measurements of cognitive style, a comparison between different measurements in a same experiment environment seems necessary. Unfortunately, few studies provide such cross-measurement comparison.

Third, we employ multiple task complexities and multiple DSS models in our research. Past studies have indicated that the variances on system cause significant difference on conclusions (Lu et al. 2001; Taylor 2004). Some authors also criticize the use of single task in IT acceptance research (Lee et al. 2003; Mathieson 1991). To reinforce the validity of our experiment, we include three types of task (structured, semi-structured, and unstructured) and three types of DSS model (cost optimization model, linear weighted-sum model, and fast-frugal heuristics) in our study in an attempt to cover the wide spectrum of these two underlying factors and their discriminating effects.

The rest of this paper is organized as follows. Section 2 presents the theoretical background. Section 3 introduces our research model and develops hypotheses. Section 4 describes planned methodology and measurements.

THEORETICAL BACKGROUND

Technological frame

To solve problems associated with the implementation of information systems (IS), Orlikowski and Gash (1994) propose using technological frames to understand users' behavior. According to them, a user's behavior with a technology is significantly influenced by his or her interpretation of that technology. A user's interpretation of the technology can be captured by the frame that he or she is using with the technology.

Orlikowski and Gash (1994) define three domains inside a frame: (1) *nature of technology*: "people's images of the technology and their understanding of its capabilities and functionality"; (2) *technology strategy*: "people's views of why their organization acquired and implemented the technology"; and (3) *technology in use*: "people's understanding of how the technology will be used on a day-to day basis and the likely or actual conditions and consequences associated with such use (p183)". These domains characterize users' interpretations of a technology and provide a conceptual framework to study users' technology acceptance behavior.

With the framework, we can describe users' DSS acceptance behavior from a holistic view. First, when users face DSS, they need to understand the nature of the DSS. They will build their own images about the capabilities and functionality of the DSS. Secondly, they need to understand why they need to use the DSS. A general motivation for acceptance of DSS is to improve effectiveness of decision making or, in other words, reduce the perceived complexity of tasks (Keen et al. 1978). Finally, users need to understand how the DSS will be used and the possible

consequences of such use. They may be concerned with questions such as whether the DSS is easy to use or whether it is useful for their tasks. Thus, a way to understand users' DSS acceptance behavior is to understand their subjective image of the DSS, their motivations to use the DSS, and their judgments on the way to use the DSS and the possible consequences with the use.

Theory of Reasoned Action (TRA) and Technology Acceptance Model (TAM)

While technological frame is useful for explaining users' behavior, contextual constructs used with the frame need to be meaningfully developed. Fortunately, for the context of our study, we can borrow important factors from relevant IT acceptance models such as TRA and TAM. Three important constructs in TRA are belief, attitude, and intention. In TRA, a specific behavior is determined by the person's intention to perform that behavior; a person's intention is a function of person's favorable or unfavorable attitude toward behavior; beliefs about consequences of behavior influence the person's attitude toward the behavior. A meta-analysis of 87 empirical studies confirms the predictive power of TRA (Sheppard et al. 1988).

Following the TRA, Davis (1989) proposes a modified model of TRA for the domain of IT: the technology acceptance model (TAM). TAM includes two beliefs — perceived usefulness (PU) and perceived ease of use (PEU) to predict attitude and intention toward behavior. TAM postulates that PU and PEU mediate effects of other external variables on attitude and intention toward behavior. Many existing studies use TAM to investigate the effect of individual difference on technology acceptance. Facing frequent inconclusive results, however, we observe that proposing individual difference as a direct external variable of TAM seems to be a dubious approach. There should be some more subtle ways for individual difference to influence users' technology acceptance behavior.

The correspondence between the technological frame and TRA/TAM is obvious. First, the capabilities and functionality of DSS (*nature of technology*) can influence users' attitude toward the DSS (Cats-Baril et al. 1987; Liang 1986; Sambamurthy et al. 1994). Second, the reason why users will consider using DSS can be attributed to the motivation of improving effectiveness (*technology strategy*), which is equivalent to reducing the complexity of task (Keen et al. 1978). Finally, perceived usefulness and ease of use are influenced by the understandings how the DSS to be used and possible consequences of use (*technology in-use*).

Task-Technology Fit (TTF) Model

Task-technology fit model is based on cognitive fit theory (Lee et al. 2007) and cost-benefit theory (Goodhue 1995). The basic idea is that when a technology provides features and support that "fit" the requirements of a task, performance of the user will be improved (Goodhue and Thompson, 1995). Compared to TAM, TTF provides a complete description of the evaluation process: users face tasks and available technology, judge "fit" among them, and accept or reject the technology. The criticism on TTF is that judgment on whether technology fits some specific requirements of tasks is viable only for simple tasks, such as low level spatial and symbolic tasks (Todd et al. 1999). For complex tasks, such as an unstructured task, it is hard to determine an optimal strategy for a good "fit" because the tasks are ill-defined and there are too many alternatives to chose.

In this study, we are specifically interested in how three input factors introduced in TTF (task characteristics, individual differences, and technology nature) affect users' acceptance of DSS. On the other hand, to cope with the criticism on judging artificial task-technology "fit" in semi-unstructured and unstructured task environment, we focus on specific relationships between factors instead of an overall "fit" evaluation. That is, we focus on how individual difference interacts with task and DSS respectively and how such interactions influence perceived task complexity and attitude toward DSS. Ultimately, we investigate how such interactions influence users' DSS acceptance behavior.

RESEARCH MODEL AND HYPOTHESE

Referring to the input structure of TTF and constructs of TRA and TAM, we develop our research model for our study (Figure 1).
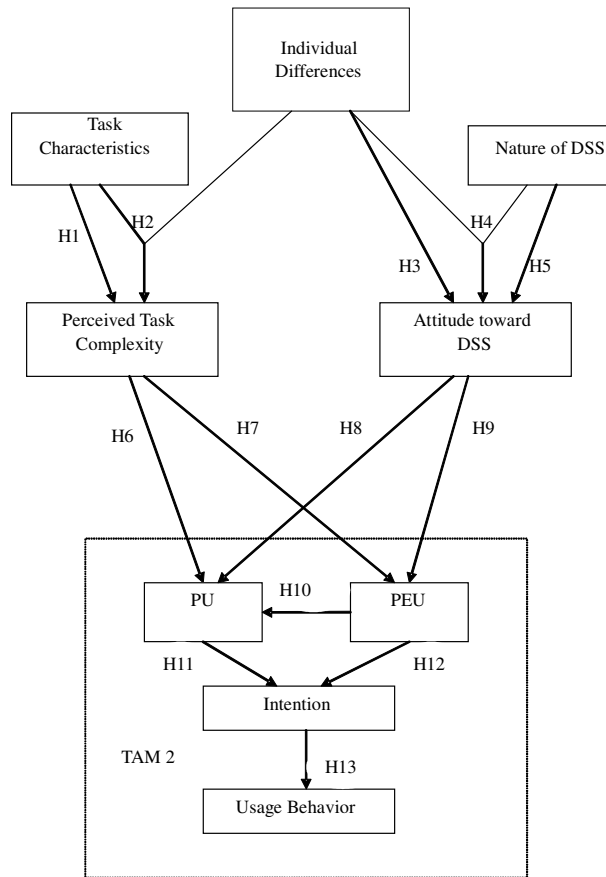
Figure 1. Research Model

Task characteristics

In the context of decision making, researchers characterize decision tasks as structured, semi-structured, and unstructured. This taxonomy originates from an early category of programmed and non-programmed task (Simon 1960). Although the level of structuredness of a specific task is criticized as a subjective measurement (Ginzberg et al. 1982), this category is widely adopted in DSS literature. Because DSS are aimed to work in semi-structured and unstructured task environment, task characteristic is frequently used to explain DSS success and user performance. There is empirical evidence that evaluation of DSS is positively related to task complexity (Sanders et al. 1985; Swink 1995). Thus, conceptual and empirical supports indicate that task characteristics should be an important factor for a study in DSS context.

Individual differences

Zmud (1979) classifies individual differences into three classes: cognitive style, personality, and demographic/situational variables. In this study, we focus on cognitive style aspect and use the other classes (e.g., gender, age, education, and computer experience) as control variables (Agarwal et al. 1999; Rafaeli 1986; Zmud 1979; Zoltan et al. 1982). Cognitive styles represent "characteristic models of functioning shown by individuals in their perceptual and thinking behavior (Zmud 1979, p.967)". The cognitive style construct is generally believed to be multidimensional (Keefe 1988; Messick 1976). In DSS field, most research focuses on the analytic/heuristic dimension (Alavi et al. 1992), which reflects person's preference for either detecting underlying causal relationships and forming "optimal" quantitative model or relying upon common sense, intuition, and experience and considering the totality of the problem situation as an organic whole (Vasarhelyi 1977).

The analytic/heuristic dimension is measured in DSS literature with different approaches. In this study, we adopt two

mechanisms, namely GEFT and MBTI, to measure cognitive style. In psychology area, there are multiple dimensions of cognitive style proposed and studied (e.g., Regan (1979) specified ten different dimensions). We recognize that there is no single precise measurement of human cognitive style; therefore, we specifically attempt to utilize multiple devices to measure the dimensions of cognitive style which can closely affect acceptance of DSS. Firstly, they are widely accepted in DSS literature (e.g., Alavi et al. 1992) and also have received popular support in psychology literature (e.g., Leonard et al. 1999). Secondly, we argue that both measures indicate the appropriate dimension of cognitive style that is closely related to evaluation of task complexity and decision tools which are the focus of this study. By choosing these two, nonetheless, we don't suggest that they be perfect measurements of all dimensions of human cognitive style.

GEFT was developed by Witkin (1967) and used to measures the field dependence/field independence dimensions of cognitive style. Individuals with high field dependence show less ability to separate objects from their environment and usually perceive parts of the environment as "fused". In contrast, field independent individuals experience parts of the environment as discrete from organized ground and emphasize more on detail and basic relationships. MBTI was developed by Myers (1962). It focuses on perception and judgment two dimensions. Perception refers to the ways a person becomes aware of things, people, and events (Myers et al., 1985). It ranges from sensing to intuition. Sensing brings to awareness what is occurring and concerns details. Intuition focuses on possibilities, meanings, and relationships and is theoretical and future oriented. Judgment ranges from thinking to feeling. Thinking emphasizes on the use of logical and objective analysis, and feeling relies on personal and groups values and is more subject than thinking. Combining the descriptions of dimensions defined in GEFT and MBTI, we can categorize that field independent dimension of GEFT is close to sensing/thinking dimension of MBTI (as analytic) and field dependent is close to intuition/feeling (as heuristic). Again, we consider adopting GEFT and MBTI measurement in this study is to make our study comparable with existing IS cognitive style research literature.

Nature of DSS

Following Simon's (1960) definition of "bounded rationality", in this study we look at both rational and behavioral decision models. The rational model assumes that individuals have complete information and applies normative and mathematical formulas to derive an optimal solution, whereas the behavior model emphasizes the bounded rationality of individuals and looks for a satisfying solution that first meets acceptable standards (Lu et al. 2001). In this study, we consider "rationality" and "behavior" two opposites of a continuum and select three DSS models across the continuum, namely cost optimization model (COM) (Baumol et al. 1958), linear weighted-sum model (WSM) (Lu et al., 2001), and fast-frugal heuristics (FFH) (Gigerenzer et al. 1996). In this study, COM represents a rational model, which focuses on tasks that are difficult because of complicated computation but structured because the problem is well-defined. An example of such task is the warehouse location decision. WSM is still believed as a rational model but it is usually used to address semi-structured and unstructured tasks such as multi-attribute decision making task. FFH is operated according to Simon's (1960) definition of "bounded rationality". It assumes that individuals are limited rational and applies rules of thumb to get a satisfying result. The FFH is believed to be generally efficient and effective (Gigerenzer et al. 1996).

Task characteristics and individual differences

Even though TTF measures task characteristic from the dimension of task complexity, it doesn't clarify the subjectivity of task complexity. It is obvious that individuals differ in their perception of the same task (Chan 2006; O'Reilly et al. 1980). In this study, we treat complexity as a task-person interaction (Campbell 1988) and distinguish perceived task complexity from given task complexity. It is reasonable to infer that given task complexity will influence the perceived task complexity. This assertion is supported by a empirical study (Te'eni 1989). Therefore,

> H1.   *When given task characteristics change from structured to unstructured, the perceived task*
>   *complexity will increase accordingly.*

The interaction between tasks and individual differences are widely observed. For example, a recent study shows that the degree of expertise of individuals significantly influences the perceived task complexity and performance (Haerem et al. 2007). In IS literature, there is evidence that individual with analytic style performs better than those with heuristic style for some structured tasks (Lusk 1979). In general, Robey and Taggart (1982) proposed a "fit" model among cognitive style, task, and information support. They argue that individuals with intuitive (heuristic) style fit better in an unstructured setting, whereas individuals with analytic style fit better in a structured setting.

Therefore,

>   *H2a.   Within a structured task setting, individual with analytic style will perceive less task complexity than individual with heuristic style.*

>   *H2b.   Within semi-structured and unstructured task settings, individual with heuristic style will perceive less task complexity than individual with analytic style.*

Individual differences and nature of DSS

According to a review of individual differences studies (Zmud 1979), extroverted and perceptive individuals show positive attitudes toward MIS. There is evidence that individuals with analytic style and high level of education exhibit positive attitudes toward computers (Igbaria et al. 1989). Because DSS are computer-based systems (Ginzberg et al. 1982), working with DSS requires systematic analysis and attentions to detail (Igbaria and Parasuraman, 1989). Therefore,

>   *H3.   Individuals with analytic style will exhibit more positive attitudes toward DSS than individuals with heuristic style.*

As we discuss earlier, the rational decision model emphasizes the use of complete information and mathematical formulas, while the behavior decision model focuses on the bounded rationality of individuals and tries to find a fast and satisfying solution (Lu et al., 2001). These attributes of models seem to correspond well to the characteristics of different cognitive styles. According to Sabherwal and Grover (1989), individuals with heuristic style prefer fast decision making and those with analytic style is expected to use all available information. Lu (1995) also shows that individuals with analytic style prefer quantitative decision support and those with heuristic style are predisposed to adopt qualitative approach. Therefore,

>   *H4a.   With behavior decision model, individuals with heuristic style will exhibit more positive attitudes toward DSS than those with analytic style.*

>   *H4b.   With rational decision model, individuals with analytic style will exhibit more positive attitudes toward DSS than those with heuristic style.*

According to Kottemann and Davis (1991), individuals' attitudes toward DSS are a function of decision conflict induced by the DSS. They define decision conflict as attributes trade-off conflicts among alternatives. For example, COM offers optimal solutions based on one attribute, it doesn't introduce decision conflict. FFH compares values in a same category of attribute and doesn't cause decision conflict too. For WSM, however, individuals have to decide the weights for different attributes and then suffer from decision conflicts. According to this view, individuals should exhibit more positive attitudes to COM and FFH than to WSM. Therefore,

>   *H5a.   Individuals will exhibit more positive attitudes toward DSS when DSS model is supplied with COM than with WSM*

>   *H5b.   Individuals will exhibit more positive attitudes toward DSS when DSS model is supplied with FFH than with WSM*

Perceived task complexity and PU and PEU

In a structured task environment, problems are well-defined and problem solving processes can be programmed; in an unstructured task environment, however, problems are ill-structured and problem solving processes are non-programmed. These definitions imply that computer-based systems work better with structured problems than with unstructured problems. Even though there is evidence that users' satisfaction with DSS is positively related to complexity of task (Sanders et al. 1985), in this study we argue a negative effect of perceived task complexity on perceived usefulness. Therefore,

>   *H6.   When perceived task complexity increases, perceived usefulness of DSS will decrease.*

There are two contradictory opinions on the effect of perceived task complexity on perceived ease of use. This first one argues that with more perceived task complexity, decision makers may expect more feasibility of DSS and ask more ease of use (Elbeltagi et al. 2005). The second opinion argues that with high perceived task complexity, decision makers will move their attention to effectiveness of decision making and require less ease of use (Lu et al. 2001). In this study, we believe that benefits of DSS should considerably depend on users' efforts to pursue solutions. We follow the first opinion. Therefore,

>   *H7.   When perceived task complexity increases, perceived ease of use of DSS will decrease.*

Attitude toward DSS and PU and PEU

There is significant evidence that attitude toward DSS is positively related to DSS performance (Alavi et al. 1992). In common sense, individuals with positive attitude toward DSS will perceive more usefulness and ease of use than those with negative attitude. Therefore,

      H8.   Attitude toward DSS are positively related to PU.
      H9.   Attitude toward DSS are positively related to PEU.

TAM test

Because there is few DSS research related to TAM, in this study we also examine the validity of TAM in DSS context. We follow these hypotheses proposed in TAM 2 (Venkatesh et al. 2000). Therefore,

      H10.   PEU is positively related to PU.
      H11.   PU is positively related to intention.
      H12.   PEU is positively related to intention.
      H13.   Intention is positively related to usage behavior.

MEASUREMENTS AND METHODOLOGY

Measurements

In past studies, GEFT (Witkin et al. 1971) and MBTI (Myers et al. 1985) have been widely used to measure users' cognitive style. Reliability and validity of GEFT and MBTI have been generally believed to be strong (Witkin et al., 1971; Carlson 1985). The measurement of perceived task complexity is developed from Goodhue and Thompson (1995). We follow the task equivocality and task interdependence dimension defined in their study. The measurement of attitude toward DSS is adopted from Hartwick and Barki (1994). The measurements for perceived ease of use, perceived usefulness, intention, and usage behavior are adopted from Lu et al. (2001) (Table 1).

Perceived Task Complexity	Task Equivocality (7 point)	EQUI1	This problem is ill-defined for me	Goodhue and Thompson (1995)
		EQUI2	This problem is ad-hoc, non-routine for me	
		EQUI3	I have never been asked to solve similar problems in quite that form before.	
	Task Interdependence (7 point)	INTR1	I believe this problem involve more than one business function	
		INTR2	I believe this problem involve more than one organization group	
Attitude Toward DSS (7 point) (α=0.99)	Indicate your feelings concerning the DSS model. I consider the DSS to be…	ATTI1	good/bad	Hartwick and Barki (1994)
		ATTI2	terrible/terrific	
		ATTI3	Useful/useless	
		ATTI4	Worthless/valuable	
Perceived Ease of Use (7 point) (α=0.72)	PEU1		The DSS is easy to use	Lu et al. (2001)
	PEU2		The process is understandable	
	PEU3		The DSS is easy to learn	
Perceived Usefulness (7 point) (α=0.75)	PU1		This model help me control the whole decision process	
	PU2		This model makes the decision process easier	
	PU3		This model is useful to me in making a decision	
Attitude Toward Behavior (7 point) (α=0.79)	ATB1		I like to make a decision with this model	
	ATB2		I like to analyze information with this model	
	ATB3		I like to judge in this way	
Intention (7 point) (α=0.79)	INTE1		I accept the procedure of this decision model for future decisions	
	INTE2		I will apply this model for hard decisions in the future	
Table 1. Measurements				

In past studies, usage behavior was measure by duration of use via system logs (Venkatesh et al. 2003), number of visits, total time of use, and number of tasks worked on the IS (Taylor et al. 1995), and self-reported average time of use every day (Venkatesh et al. 2000). In the case of DSS, however, the situations are a little different. For example, compared to email system, the frequency of DSS use is far lower. Moreover, DSS is more task-oriented (such as buy or make decision) than function-oriented (such as communication). Whether users accept the suggestions offered by DSS should be included in measurement of DSS usage behavior. In this study, because the use of DSS for the tasks is voluntary, we combine the total time of DSS use and whether users accept the suggestions offered by the DSS as measurement of DSS usage behavior. The examples of questions that measure whether users accept the results of DSS include "I didn't use the decision model for the decision task at all", "I tried the decision model for this decision task, but rejected its result and made a decision by myself", and "I used the decision model for this decision task and reported its result. But the reason why I used it is that I didn't have other decision supports available. In fact, I don't trust the result of the decision model", and "I used the decision model for this decision task and accepted its result". We treat the first two as non-acceptance of DSS, and the last two as acceptance.

Methodology

The subjects are 300 business students at a mid-west university. The use of students as subjects is justified by Lu et al. (2001). We adopt a warehouse location problem as the structured task (Gorry et al. 1971), a choice of new business office as the semi-structured task (Skyttner 1999), and a hiring new managers problem as the unstructured task (Cooper 1985). Subjects are randomly assigned to 5 groups (Table 2). We use WSM and FFH across semi-structured and unstructured task environment. The data will be collected in two sessions.

Structured task & COM	Semi-structured task & WSM	Unstructured task & FFH	Semi-structured task & FFH	Unstructured task & WSM
Group1	Group2	Group3	Group4	Group5
Table 2. Experiment groups				

Session I. The MBTI is administered to groups of subjects. Then subjects are asked to evaluate complexity for each task. We separate the task from the DSS appraising process in two sessions to avoid the possible disturbance with each other.

Session II. The GEFT is administered to same groupings approximately two weeks later. Each group is given a 10-minute instruction of one of the decision models. Subjects are allowed to ask questions and practice operations of the decision model on computers during the instruction. After that, each subject is given a decision package, which includes required task and data for performing that task. Subjects are given 6 alternatives and each alternative includes 5 attributes. Each DSS model is programmed as a software application provided to subjects. Subjects need to write down their decision result on paper and answer follow-up questions. Subjects also are told that their performance would be assessed and the top 10% would win $20 cash respectively.

Linear regression analysis will be used to test relationships between factors. Structural equation modeling or partial least square technique will be used to test the explanation power of the research model. .

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