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Dialectic Decision Support Systems: The Design and Evaluation Framework

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ABSTRACT

Many complex and unstructured decisions are hindered by a lack of clear understanding of various underlying assumptions and perspectives involved in the decision process. At present, little attention is paid to the elicitation of underlying assumptions and perspectives in dealing with complex issues in traditional decision support systems (DSS). We argue that the Socratic dialectic inquiry is an effective method for dealing with unstructured problems that are complex and require the involvement of different perspectives in DSS. In this paper, we propose a design for Dialectic Decision Support System (DDSS), in which dialectical processes are integrated with traditional DSS in order to support individual users. We propose the design of DDSS and formulate a conceptual model for testing the superior efficacy of DDSS compared with traditional DSS. The potential contribution of this research is in providing a greater level of support for critical thinking, dealing with complex decision problems, and identifying creative solutions.

Key Words

Dialectic Approach, Dialectic Decision Support Systems, Complex Decisions, DDSS Design

INTRODUCTION

Researchers have known that decision makers (DMs) on their own are incapable to make the best decisions when the problem is complex. Socrates—one of the most influential philosophers in ancient Greece—argued that not all men are capable of seeking the “truth knowledge” or dealing with problems without the help from others (Scott, 2002). Using inquiry dialogues, Socrates helped his students discover by themselves that they failed to have the answers (or “the truth knowledge”) they believed they had (Scott, 2002 p. 106). Simon’s (1977a) bounded rationality theory explains the role of human’s limited cognitive process in discouraging DMs from pursuing the optimal solution. Tversky and Kahneman (1974) argue that DMs are open to serious errors and biased decisions because they use “rules of thumb” or heuristics for making decisions.

The underlying motivation for developing decision support systems (DSS) has been to provide support by complementing the DMs’ cognitive resources. However, empirical studies indicate that less motivated DMs were willing to settle for inefficient decisions by using more comfortable but less effective strategies in order to conserve their cognitive effort/energy (Todd and Benbasat, 1999). Furthermore, while understanding underlying assumptions in various decision options plays an important role in tackling complex and unstructured decisions (Mason and Mitroff, 1981), traditional decision support systems (DSS) have paid little attention to the elicitation of underlying assumptions and perspectives in dealing with complex issues.

In organization studies, structured conflict approaches—the dialectic approach and devil’s advocacy—are used to broaden a DM’s perspectives in group decision making when dealing with unstructured tasks (e.g. Cosier, 1981; Schwenk, 1990). Following the Socratic dialectic approach in philosophy, dialectic inquiry is used for providing a critical perspective to the decision making process and thus improving decision quality (Mason and Mitroff, 1981; Mitroff and Emshoff, 1979). Empirical studies found dialectical approach to be effective in helping DMs in unstructured tasks (e.g. Schwenk and Valacich 1994). These findings lead naturally to two questions. First, can one design a DSS with dialectic component (dialectic DSS or DDSS)? Second, what, if any, are the factors that contribute to the successful use of DDSS in making complex decisions?

In answering these two research questions, this paper first proposes a DDSS design, in which traditional DSS is integrated with a dialectical approach and advanced technology to aid DMs in improving their decisions for unstructured tasks. In doing so, we draw on the Socratic school of thought, the Hegelian triad, research on dialectic inquiry, and advanced technologies in intelligent systems in order to provide the knowledge base and intelligent interface for engaging DMs in the dialectic process. This design heeds the call by Shim et al. (2002) that DSS designers should incorporate the emerging IS technologies in DSS to enhance the systems’ capabilities to better address the needs of DMs. Secondly, drawing on theories

in task-technology fit, self-efficacy, goal setting, and technology acceptance model, we develop a conceptual model for evaluating the efficacy of the proposed DDSS.

The increasing complexity of decisions encountered by individual and organizational DMs and the global or far reaching interdependencies of decision consequences have created a mandate for a more potent class of DSS. This study is the first in the development of DDSS, and has the potential to contribute to the creation of support tools in making complex and difficult decisions and to find creative ways in dealing with new circumstances.

DIALECTIC APPROACH AND ITS APPLICATIONS

In this section, we briefly discuss the related theories and literatures in the dialectic approach, which guide the development of the DDSS design.

Critical thinking through Dialectic Approach

Critical thinking or critical reasoning is a major topic in several disciplines, which are interested in enhancing the effectiveness of human judgment and decision making (e.g. Ennis, 1992; Gold et al., 2002). Critical thinking is a skill needed for many complex problems, in which implied assumptions, regularly held beliefs, and normal procedures can not be successfully used to solve a decision problem. Critical thinking is used to question old ways of problem solving and to search for alternative assumptions, beliefs, or procedures to arrive at innovative solutions. Halpern (1984) defines critical thinking as thinking with a purpose and a goal that involves reflective or healthy skepticism, deepening the background knowledge about the decision problem, and a willingness to engage in a greater cognitive effort in selecting facts and assumptions to use (McPeck, 1992). Although there are different schools of thought about the approaches and contents of teaching critical thinking (Ennis, 1992), there is a consensus that critical thinking skills can be taught and acquired (Halpern, 1984).

Teaching and use of critical thinking date back to ancient Greece, when philosophers such as Plato and Socrates taught their students to think critically by questioning beliefs and reasons used by themselves and by those who had different perspectives—the dialectic approach (Rychlak, 1997; Stace 1924). The dialectic approach considers both the existing alternatives and explanations of a phenomenon and its other possible alternatives and explanations through the interaction between two opposing views (Basseches, 1984).

The Practice of the Dialectic Approach

According to Rychlak (1997, p. 192), Socrates required his students “*to think for themselves—to be critical, exact, and tenacious in pursuing any point under consideration*” using a dialectical inquiry. Socrates took an opposition role by asking a series of questions, with the intention that students would come to self-realization with new knowledge when they could not respond to Socrates’ questions with a strong argument.

Hegel, one of the most influential modern philosophers, formulated the fundamental principle of his dialectical philosophy based on the Socratic school of thought. According to Stace’s interpretation (1924), the negation principle is that “*to deny that a thing belongs to one class is to affirm that it belong to some other class*” (p. 33). Hegelian dialectical approach is developed as a triad system that describes the flow of thought. The three members of a triad are thesis, antithesis, and synthesis. Thesis is an initial affirmation that explains itself as a positive assertion. Antithesis is the opposite of thesis that denies what thesis affirms. Antithesis is deduced from thesis. In another word, thesis leads to antithesis. The confrontation between thesis and antithesis produces a contradiction that results in a reconciliation, leading to synthesis. Synthesis is a combination of the best of thesis and antithesis. Churchman (1971) observes that in Hegelian inquiring systems, the designer undertakes with full conviction “*to construct a ‘case’ for a point of view, in effect in defense a thesis*” (p. 171). The relevant items of information are those that are evidence relative to the thesis and lend “*positive zero, or negative credence to the thesis*” (p. 172). Then, the observer questions why the thesis is true and wonders if “*another conviction wouldn’t do just as well,*” leading to the antithesis, which Churchman calls “*deadliest enemy of thesis*” (p. 172). The synthesis is the result of conflict between the thesis and antithesis. It is not a compromise, but has a higher or broader view of reality. It is a “*super-proposal*” that absorbs the conflict between them. The process is not mechanical, but involves dynamic interactions for self-realization (Buss, 1979).

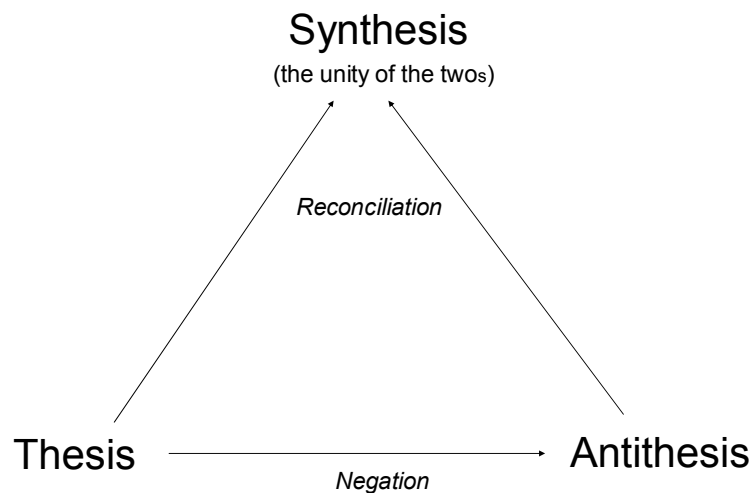


Figure 1. The Hegelian Triad System

In management, the dialectic approach has been applied in dealing with complex problems such as strategic decision making and planning. The dialectic approach is embedded in the decision-making process to promote a healthy conflict among DMs that allows them to be more critical and creative. Organizational researchers and practitioners have long recognized the importance of healthy conflicts in decision making and problem solving (e.g. Janis and Mann, 1977; Marakas and Elam, 1997). Dialectical inquiry and its variation in the form of devil's advocacy have been promoted to alleviate group thinking in group decision making and to improve decision performance.

Mason (1969) uses the dialectic approach to promote structured cognitive conflicts in group decision making for dealing with complex planning problems. His dialectic inquiry involves a plan (thesis) and a counterplan (antithesis) in forming a new plan with expanded perspectives (synthesis). Similarly, Mitroff and Emshoff (1979) use the dialectic approach to develop their strategic assumptions analysis model for the analysis of business strategies. Cosier (1981) adopts a devil's advocacy approach, in which an individual is assigned as the devil advocate to criticize the original assumptions to formulate antithesis, and a third party (normally a manager) contrasts thesis and antithesis to arrive at the synthesis for assumptions and arguments.

Empirical studies report the dialectic approach to be more effective than using an expert for the analysis of assumptions, and devil's advocacy to be even more effective than dialectical inquiry (e.g. Schwenk, 1990; Schwenk and Valacich, 1994; Valacich and Schwenk, 1995). However, Basseches (1984) argues that devil's advocacy and dialectical approach are the same, since both promote dialectical critical thinking.

The business applications of the dialectic approach have been mostly in group settings without any IT support, and require engaging in organized conflicts. However, there are circumstances, in which engaging in structured conflicts may not be possible or desirable for DMs. We argue that incorporating the dialectic approach in DSS could assist individual DMs in their complex decision problems, reducing the need to engage in organized group conflicts.

Incorporating the Dialectic Approach into DSS

Simon (1986) observes that DMs have bounded rationality due to their limited information processing abilities. Furthermore, the distraction and momentary emotions could reduce the DM's ability to process information in short term memory, which results in sub-optimal decisions. Moreover, Payne et al. (1993) argue that DMs may have other objectives in mind than arriving at the optimal decision, such as reducing the decision making effort. Furthermore, DMs' knowledge and prior experiences can influence how DMs select information, strategy and criteria in their decision making. Expert DMs, who possess great depth of knowledge in a problem domain, are effective at recognizing appropriate strategies for decision making (Shenk et al., 1998). In decision-making activities, expert DMs develop "rule-of-thumb" strategies to solve problems

effortlessly (Kahneman and Frederick 2002). However, relying on prior experiences and rules-of-thumb may blind DMs to alternative perspectives and assumptions (Clemen, 1991). While using rules-of-thumb and prior experiences may expedite routine and familiar decisions, they may hinder the discovery of new and creative ways to address unstructured problems that require different perspectives.

Valacich and Schwenk (1995) study the effectiveness of dialectical inquiry in both fact-to-face and computer-mediated environments and report that some of their subjects (undergraduate students) did not engage in dialectic process to generate an “optimal” solution. This could be the result of the additional cognitive efforts and skills needed for initiating and engaging in the dialectic process. This point of view is supported by Fasolo’s (2002) findings that DMs can better deal with conflicting information when decision aids are used. Thus, we argue that the use of DDSS can help expert and novice DMs engage in critical thinking needed for dealing with difficult and complex problems.

THE DESIGN OF DIALECTIC DECISION SUPPORT SYSTEMS

Traditionally, DSS is designed to support DMs to improve decision outcome for semi-structured tasks. However, the need for a DSS design with a stronger emphasis on the early stages of decision making has already been recognized. Todd and Benbasat (1999) suggest that DSS should guide DMs to select the most appropriate decision strategy. Belardo et al. (1994) propose strategic DSS, which incorporates multiple conceptual models to support senior managers and to train managers to include different perspectives in dealing with complex strategic decisions. Their system allows DMs to incorporate different perspectives into the decision-making process.

Dialectic decision support systems take a different approach to influence DMs by assisting them on *how* to think critically rather than *what* to think. We argue that by providing a guidance for critical thinking, based on the dialectic approach, the system is more effective in helping DMs solve unstructured tasks that are complex and have no “cut-and-dried” formulation. In addition, DDSS could help DMs overcome their cognitive limitations and unwillingness to engage in structured conflicts.

The Design Framework of DDSS

The design of the DDSS consists of four modules: DSS, the dialectic knowledge base, visual aids, and the intelligent interface for handling the dialectic process as well as the DSS, as shown in Figure 2.

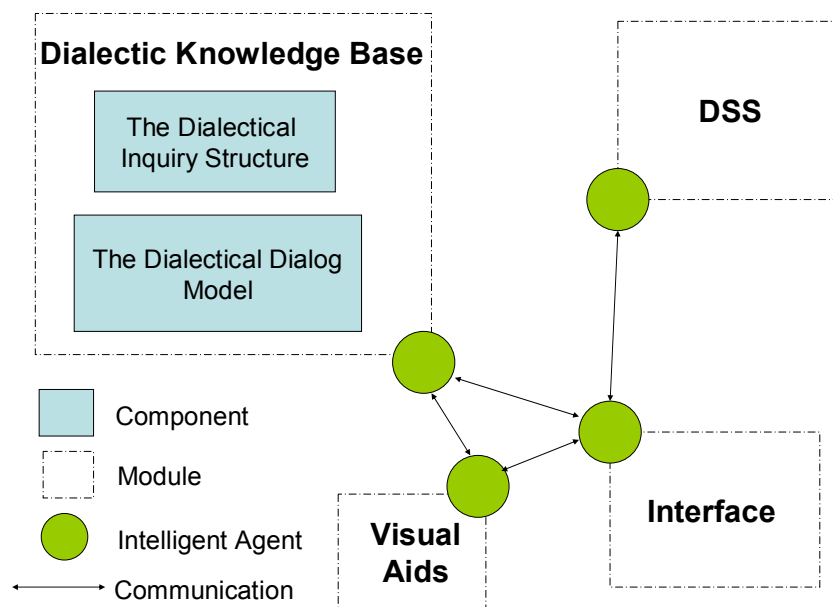


Figure 2. The DDSS Design Framework

A dialectic knowledge module consists of two main components: the dialectical inquiry structure and the dialectical dialog model. The dialectical inquiry structure is a flow structure of the dialectical inquiry process used to guide DMs in a dialectic analysis. Following Mason and Mitroff (1981), the dialectical inquiry structure includes the stakeholder generation process,

the assumption surfacing process, the dialectical debate process, and the integration the assumption process. The dialectical dialog model contains of a set of questions and a set of rules for interacting with DMs to elicit and clarify the perspectives and underlying assumptions in the decision process. A sample list of questions in the dialectical dialog model is listed in Table 1.

Process	Questions
Stakeholder Generation	<ul style="list-style-type: none"> - Who is affected by the decision? - Who has an interest or stake in the decision and its consequences? -Who can impact the decision's acceptance and implementation? -Who has expressed alternatives for the issues involved? -Who, because the personal profile or other characteristics, ought to care or might care about the decision?
Assumption Elicitation	<ul style="list-style-type: none"> - What should we assume about this stakeholder and its future behavior in order for the decision to be successful? - How much damage is done if counter assumptions are true?

Note: Adapted from Mason & Mitroff (1981)

Table 1. A sample List of Inquiry Structure in the Dialectical Dialog Model

Since DMs have to interact with the system, it is important for DMs to accept an idea or be challenged by a question generated by the system. The system has to show competency in interacting with DMs. The intelligent interface is critical for a meaningful interaction with DMs. The modules communicate through their intelligent agents. Each intelligent agent has a knowledge base for interaction with other modules.

According to DiBiase (1990), DMs use visualization aids to explore problems and to verify assumptions and hypotheses. Visual representations are found to assist individuals to better assimilate and understand new concepts (Kraidy, 2002). Therefore, DDSS will provide visual representations for each step of dialectical analysis. Mitroff and Mason (1983) suggest several visual representation tools for complex managerial problems. Chen and Lee (2003) argue that the tools can aid DMs to recall past experiences, to reflect on their assumptions and beliefs, and to envision or understand the consequences of decision options. The list of visual tools and their descriptions are shown in Table 2.

The proposed design uses an integrative approach that combines the dialectic approach at the intelligence phase of decision making with the subsequent phases using traditional DSS. Based on the premise that the use of a dialectic approach in a decision-making process will improve the process, we propose that DDSS is most appropriate for complex, difficult and unstructured decisions. The DDSS design system will be validated through case studies of a DDSS prototype.

Tools	Description
Stakeholder Assumption Form	It is used to list each stakeholder's assumptions and counter-assumptions.
Assumption Plotting Graph	It is used to assist decision makers to rank assumptions based on the degree of importance and certainty. The assumptions that are most significant to the decision are viewed as important and certain to occur.
Most Damaging Assumption Form	It is used to list the assumptions that will damage the current decision the most.
Assumptions Decision Table	It is used to compare assumptions based on the cost of implementing different decisions, the real cost of an assumption, the visible cost of an assumption, the reversibility of an assumption. Mason and Mitroff (1981) recommend the use of the table when synthesis between assumptions cannot be achieved.

Note: Adapted from Mason & Mitroff (1981)

Table 2. A Sample List of Visual Representation Tools

THE EVALUATION FRAMEWORK OF DIALECTIC DSS

In this section, we develop a conceptual model for evaluating the efficacy of DDSS. The structure of the model is presented in Figure 3 and discussed below. The construct definitions and scale references are reported in Table 3.

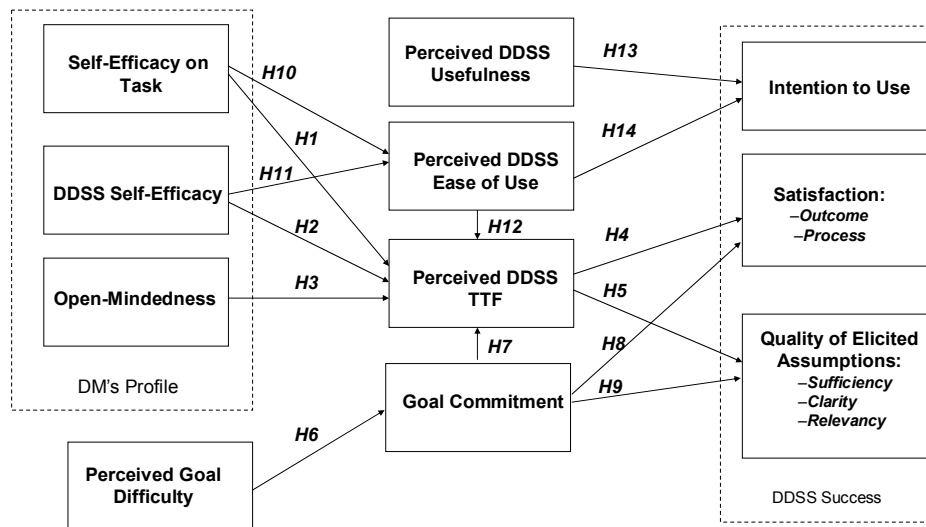


Figure 3. The DDSS Efficacy Model

Simon (1977b) identifies three phases for decision making: intelligence, design and choice. While all phases of decision making process are important to the success and quality of a decision, we argue that the intelligence phase should be examined first because intelligence phase is the foundation for the following phases. As when building a house, if decisions are based on a shaky foundation (assumptions), the quality of decision is at risk.

Construct	Operational Definition	Supporting Literature
Intention to use	Individual feelings about using the DDSS for future decisions.	Davis 1989
Satisfaction	Feeling satisfied, pleased, contented, and delighted of decision outcome and process.	McKinney et al. 2002
Quality of elicited assumptions	The perception that assumptions are sufficient, clear, and relevant.	A new developed measurement.
Perceived ease of use	The belief that using the DDSS will require little effort.	Davis 1989
Perceived usefulness	The belief that using the DDSS will lead to a better decision.	Davis 1989
Perceived TTF	The perception that the DDSS capabilities match the DM's task requirements.	Goodhue & Thompson 1995
Perceived goal commitment	The determination to try for the decision goal and the persistence to attain the goal over time.	Locke et al. 1981
Perceived goal difficulty	The perception of the difficulty of the decision goal.	Locke et al. 1981
Self-efficacy	The belief of having the ability to use technology or to perform a task effectively and efficiently.	Marcolin et al. 2000
Open-mindedness	Innovative, ready, flexible, foresighted about new possibilities and ideas.	Derman et al. 1978

Table3. Construct Definitions and Sources for Scale Development

According to Mitroff and Emshoff (1979), assumption elicitation and assumption challenging are critical steps to successfully and effectively solve complex problems and find innovative solutions. As a result, it is reasonable to evaluate the success of DDSS in terms of its success in the first phase of decision making. Consequently, the quality of assumptions made in the decision process constitutes a measure of DDSS success and is a dependent variable in our conceptualization of the efficacy of DDSS. This construct is a second-order factor, with sufficiency, clarity, and relevancy as its sub-dimensions. The other dimensions of DDSS success include intention to use DDSS and satisfaction. The latter is also a second-order construct, which has satisfaction with process and satisfaction with outcome as its sub-dimensions.

The first set of hypotheses in Figure 3 deals with antecedents of the DDSS success that are related to the capability of the DDSS in helping DMs overcome their limited cognition resources. DMs are required to have broader perspectives when solving unstructured tasks. Using fit as profile (Zigurs and Buckland, 1998), we argue that DDSS is congruent with complex and unstructured tasks, since implicit assumptions in the traditional DSS may also cause DMs to narrow their perspectives or have biased assumptions in their decision process. Based on the task-technology fit (TTF) theory (Goodhue and Thompson, 1995), we posit that DMs using DDSS will perform better than those using traditional DSS for complex decisions.

We differentiate TTF from two perspectives: the DDSS designer's perspective and the DM's perspective. TTF with the designer's perspective is defined as the congruence of the designed capabilities of DDSS and task requirements (Zigurs and Buckland, 1998), whereas the DM's perspective or *perceived* TTF is defined as the congruence among the perceived capabilities of DDSS, task requirements, and the competence of DMs with the decision task and the DDSS (Marcolin et al. 2000).

In the social cognitive theory, self-efficacy is found to influence an individual's outcome expectation (Compeau and Higgins 1995a, 1995b; Compeau et al. 1999). Furthermore, Marcolin et al. (2000) argue that self-efficacy impacts performance expectation through perceived task-technology-user fit. Hence, the designer TTF may not always lead to the task-technology-user fit or *perceived* task-technology fit. For DMs to perceive fit between DSS and task, they have to believe that they can use the technology effectively and know how to solve the problems effectively. Furthermore, to engage in dialectical thinking, DMs have to be open-minded about multiple perspectives. Therefore, the hypotheses regarding perceived TTF are as follows:

- H1) *The higher the DM's task self-efficacy, the higher perceived TTF.*
H2) *The higher the DM's DDSS self-efficacy, the higher perceived TTF.*

- H3) The higher the DM's open-mindedness, the higher perceived TTF.*
H4) The higher perceived TTF, the higher satisfaction.
H5) The higher perceived TTF, the higher the quality of elicited assumptions.

The second set of hypotheses deals with the role of DMs' motivation to expend effort in using the DDSS. According to Warm (1984), successful task performance requires DMs' attention to the task at hand. We use goal setting theory to manifest DMs' intensity and duration of attention in broadening their perspectives during the decision-making process.

According to the goal setting theory, goal commitment is moderator of the relationship between the goal difficulty and performance (Locke et al., 1988). DMs are more satisfied with performance when they achieve their perceived goals. The difficulty of the goal influences the extent of DMs' commitment in achieving them. On the other hand, a higher level of goal commitment leads to higher DDSS success. Therefore, the hypotheses regarding the motivation of DDSS based on goal setting theories are:

- H6) The higher perceived goal difficulty, the lower the level of goal commitment.*
H7) The higher goal commitment, the higher perceived TTF.
H8) The higher goal commitment, the higher satisfaction.
H9) The higher goal commitment, the higher the quality of elicited assumptions.

The continuation of using the DDSS is another indication of its success, which is captured by the intention to use construct. Drawing on the TAM model and its extensions (Davis, 1989; Venkatesh et al. 2003), we argue that the ease-of-use and perceived usefulness of DDSS impact the intention to use the DDSS. This is in line with Goodhue and Thompson's (1995) model, in which ease-of-use is one of the dimensions of TTF. The hypotheses regarding the intention to use DDSS are:

- H10) The higher the DM's task self-efficacy, the higher perceived ease of use.*
H11) The higher the DM's DDSS self-efficacy, the higher perceived ease of use.
H12) The higher perceived ease of use, the higher perceived TTF.
H13) The higher perceived usefulness, the stronger intention to use DDSS.
H14) The higher perceived ease of use, the stronger intention to use DDSS.

CONCLUSION

In this study, the central question is whether DSS integrated with a dialectic approach called dialectic DSS (DDSS) could be designed to help DMs expand their perspectives when facing with complex unstructured problems. Following the literature on dialectic approach, we argue that DDSS equipped with a dialectic knowledge base will support DMs in the self-discovery and elicitation of assumptions during the intelligence phase of decision making process for complex and difficult unstructured decisions. We proposed the design of the DDSS and developed a conceptual model for evaluating the efficacy of DDSS. This work will be extended by implementing the proposed design and testing its efficacy by using the conceptual model in a controlled lab experiment.

With the increased complexity of decisions and their global and far-reaching consequences, there is an acute need for support systems designed to identify creative solutions and to think "out-of-the-box" in dealing with difficult issues and identifying innovative strategies. The potential contribution of this research is in promoting an integrated approach in DSS for dealing with such decisions.

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