International Journal of Scientific & Engineering Research Volume 8, Issue 8, August-2017 1849
ISSN 2229-5518

Towards a global DSS evaluation framework using decisional guidance

Khaoula Boukhayma, Abdellah Elmanouar

Abstract— There is a considerable amount of research work covering the evaluation of decision support systems. Many methods have been proposed, but no consent has been made yet on a global model covering the needs of evaluators. Decisional guidance is guidance for judgmental inputs provided to the user while interacting with a decision support system (DSS). By exploring the empirical studies linking DSS effectiveness to the implementation of decisional guidance, we came to propose an evaluation approach for Decision support systems evaluation using decisional guidance. The model uses guidance elements as evaluation criteria to assess decision quality, user satisfaction, user learning and decision-making efficiency.

Index Terms— Decision support systems, Decision Making, Decisional Guidance, Software Evaluation.

1 Introduction

Decision support systems (DSS) tools are often tasked with bridging the gap between an increasingly diverse business world and a portfolio of large IT applications, increasingly standardized and consolidated associated with highly specialized legacy applications that are proving difficult to replace or integrate. They are essential aids to decision making process, yet, there is still no universally accepted measure of DSS value.

Shim et al. (2002) traced the development of DSS and looked ahead to the twenty-first century as being one of “active support” in which intelligent DSS and software agents interact with the user in a distributed environment over the Web. An example of such a system is provided by Silverman et al. (2008) in which a DSS assists in identifying potential terrorist activities. Modern DSS continue to demonstrate their value to improve decision making outcomes.

As systems have grown in complexity and cost, it has been argued that the business value of information technology (IT) systems in general is difficult to quantify, making IT investment decisions challenging (Kohli and Devarali, 2003).

There is a considerable amount of evaluation frameworks for software evaluation, most of those are domain specific, and are not adaptable to decision support systems

In the case of DSS, one way to assess their value is to evaluate them based on their goal, i.e. the “decision value” of the DSS. The literature indicates that the value of a DSS is its effect on the process of, and/or the outcome from, decision making (Forgionne, 2000).

- *Khaoula BOUKHAYMA is currently pursuing a Phd program in information technology in University Mohammed V of Rabat - Morocco. E-mail: boukhayma@gmail.com*
- *Abdellah ElMANOUAR is currently an associate professoc In ENSIAS University Mohammed V of Rabat - Morocco. E-mail: elmanouar@um5s.ma*

That is, the DSS can improve the way the decision is made, and/or it can improve the outcomes from the decision. Both impacts have potential value to the individual decision maker.

Pomerol and Adam (2008) suggested that a more useful model related to technology support for decision making is to consider the process of decision making. The best decisions are coming from a largely sequential series of steps through a so-called rationalist approach (Pohl, 2008). Simon (1990) provided the most widely accepted process of decision making consisting of intelligence, design, choice and implementation. Decision making is seen to follow these steps, with feedback loops, in which the decision maker seeks information, develops a decision model, selects an alternative, and implements the decision.

Phillips-Wren et al. (2009) suggest a detailed schematic of DSS architecture (Fig. 1.). The system is using a database of decision related data, along with a knowledge base and a set of models to formulate the problem, structure the decision issue and determine solutions to generate status reports, forecasts, recommended decision actions and explanations for the recommendations.

DSS interferes then in the decision-making process, composed of the following steps: (i) Intelligence: the phase where the decision problem is formulated, the solution objective is defined and data is collected. (ii) Design: where a model is structured prioritizing courses of action. (iii) Choice: Step when alternatives are evaluated, leading to the selection of best solution and the generation of an implementation plan (Turban and Aronson, 1998; Forgionne et al., 2005).

Another step has been added by Mora et al. (2014), Learning, during which outcomes are analyzed and synthesized.

As DSS design features motivate how much a decision maker interacts with the DSS, DSS design should be deliberate and purposeful. To support decision making process, most of the systems provide decisional guidance (Silver, 1991a), explanations (Gregor and Benbasat, 1999) or decision aids (Todd and Benbasat, 1991).

Silver (2005) proposes a revised definition of decisional guidance in the context of decision support systems as “The design features of interactive computer-based systems that has, or are intended to have, the effect of enlightening, swaying, or direct

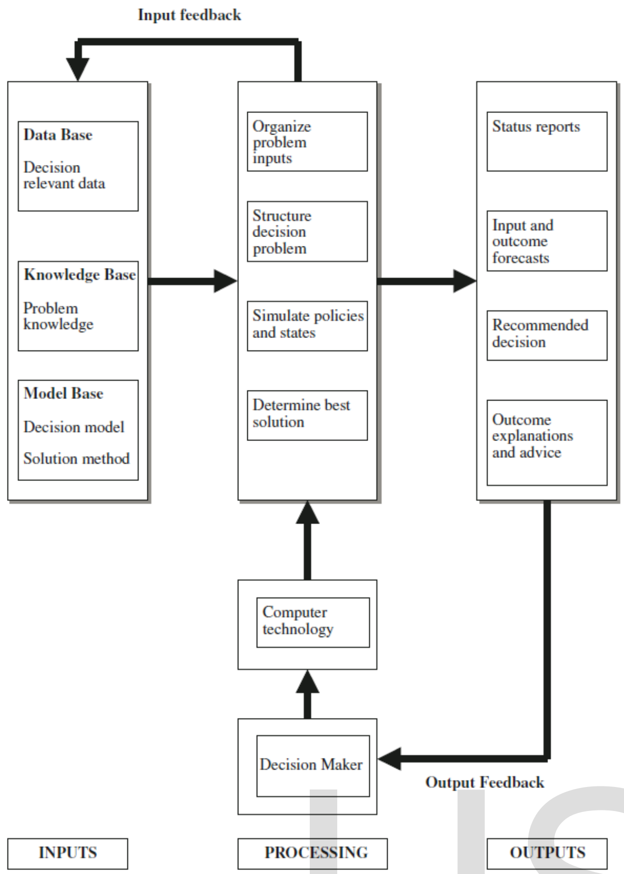


Fig. 1. DSS architecture (Forgionne et al., 2005)

ing its users as those users exercise the discretion the system grants them to choose among and use its functional capabilities."

Our work aims to examine the relationship between Decisional guidance and DSS evaluation. Such that the potential for providing a source of evaluation criteria embedded in the DSS design features and preferences expressed by the user. We will address the use of decisional guidance in building a global framework for DSS evaluation. By combining research findings discussing the effects of decisional guidance on DSS effectiveness and efficiency, along with existing models and frameworks of DSS evaluation, we propose an adapted global approach DSS evaluation focusing on the decisional guidance as a source of evaluation criteria verified with an AHP method.

2 Evaluating Decision Support systems

Since investment in DSS comes at high cost, evaluating those systems became an important Research interest. The decision with a DSS may result in improved profit, decreased cost, or improved accuracy in prediction. As DSS have evolved technologically, they have also had more influence on the process of decision making. Modern DSS enable faster decision making and in real-time, more personalization and adaptability to support user preferences, reduced decision making time via the use of sophisticated analytical and calculating methods, distributed decision making though dispersed teams and organizational learning by linkage to systems such as knowledge management systems.

This new steam of features fed the emergence of new approaches to the question of evaluation.

There are two different approaches to the question of evaluation: Process-oriented and outcome-oriented. The decision outcome is defined as the set of results accruing to the organization and decision maker. The decision making process can be defined as the set of its phase activities, while each phase can be defined as the set of its step activities (Phillips-Wren et al., 2009).

The objectives of system evaluation are to assess the compliance to the user's needs, to the required tasks, and users' better performance with the new system (Kirakowski and Corbett, 1990).

The literature suggests several methods of DSS evaluation, ranging from the cost/benefit studies focusing on a single criterion, to the value analysis, estimated more appropriate. Holsapple and Whinston (1996) suggested coupling evaluation standards with setting objectives, since some benefits of DSS are intangible, subjective and difficult to quantify.

TABLE 1
Evaluation Frameworks

Study	Focus	Criteria
Cheri Speier (2006)	Decision Making Performance	Information presentation Task Complexity
E. Ben Ayed & M. Ben Ayed (2016)	Knowledge discovery from Data process	Utility, Usability, Interestingness
Gloria Wren et Al. (2010)	Process performance Organization and decision maker Multi-criteria Model	Decision-making Level Decisional service-task Level Architectural-capability Level Computational symbol-program Level
Arvai & Froschauer (2010)	Risk management decision's outcome	Decision Quality Decision-making process
Mora et al (2014)	DSS Value in Group Decision making	Capabilities and Processes User satisfaction & Performance
Sharda et al (1988)	Design Science, DSS design	Effectiveness Efficiency
Bharati and Chaudhury (2004)	Information quality Information presentation	Decision-making satisfaction
Swink and Speier (1999)	Task characteristics	Decision Quality & Decision Time
Parikh et al. (2001)	Decisional guidance Vs Non-Guidance	Decision Making Efficiency Decision quality

		User satisfaction User Learning
Eierman et al. (1995)	DSS capability, Implementation strategy User, Task, DSS configuration	Performance User behavior
Bruggen et al. (1998)	MDSS support	Performance Decision quality

Turban and Aronson in (1998) stated that information "systems are evaluated and analyzed with two major classes of performance measurement: effectiveness and efficiency." Effectiveness measures the goals achieved by the system and its output, while efficiency is more concerned about how the inputs and resources are used those goals. Thus for any framework aiming at a global evaluation should include both these two factors, and hence the use of a multi-criteria evaluation.

Table 1 lists a survey of some approaches to evaluating DSS that used different measures to assess Decision value focusing more on system efficiency (decision process) and effectiveness (system-outcome).

The decision value was measured by different variables such as task complexity and ease of use, utility, usability, quality, user satisfaction, system performance, decision making time, business profitability...etc. In different levels of the decision making process.

Most of the methods described above and enumerated in (Boukhayma and Elmanouar, 2015) are using a multifaceted/ multi-criteria approach based on technical, empirical and subjective evaluation. Technical evaluations are domain-specific methods that assess analytical models, algorithms, data flow, system logic, cost analysis of the system development, system test and similar objects of evaluation. Empirical evaluations tend to focus on validation of the DSS. They are defined by Sojda (2004) as "examining whether the system achieved the project's stated purpose related to helping the user(s) reach a decision(s)". Subjective Methods are meant to evaluate the effectiveness of the system from different perspectives. All relevant groups: Developer, user, organization, and decision maker… should be involved in the evaluation process and respective criteria collected in the requirement analysis phase are to be taken into consideration when performing the evaluation.

While the Multi-faceted approach makes it possible to combine the needs and opinions of multiple facet-players, it remains unorganized and not easy to fit in a system development cycle (Rhee and Rao, 2008).

Another approach to DSS evaluation is the sequential evaluation. It can occur in different life-stages of the system as a correlation appears to be eminent between the development and the evaluation process. The sequential methods are using evaluation process that starts with criteria definition, followed by formative evaluation, evaluation of outcome and summative evaluation (Silver, 2008).

Finally, global approaches, adaptable to domain specific DSS. They are based on evaluating three main value measures: Quality, Efficiency and Satisfaction, against two dimensions Decision Value and Decision Maker, in order to measure the effectiveness of DSS (Silver, 1991b). Work on this area has been scarce and there is room for further research to elaborate a global method for DSS evaluation covering more measures. We address this gap in the next sections.

3 Decisional guidance for DSS

Decisional guidance was first studied in the context of decision support systems (DSS)—systems that affect, or are intended to affect, how people make decisions (Silver, 1991a), DSS use decision aids (the set of choices available for the user) that are crucial to the decision-making process and outcome, and decisional guidance is about understanding how the system features affect the user choices.

It has become widely accepted that decisional guidance has some positive effects on Decision making. Research work investigated the usefulness of decisional guidance in a DSS, the findings suggest that it helps users make better decisions and contributes to the efficiency and effectiveness of the system. Furthermore, guidance strategies that deliver suggestions based on the history of user interactions are more effective than the strategies that provide canned information to the users. It can also affect the user acceptance, perception of the system, quality of the decision, decision making time and user learning.

Guidance can have a positive impact on the user acceptance and the perception of the system (Gregor and Benbasat, 1999). Furthermore, it can increase the user satisfaction and improve decision making effectiveness and efficiency by contributing to a better learning, improved performance and decision quality (Silver, 2006), along with improving the user experience when interacting with a system and in dealing with its complexity (Mahoney et al., 2003).

Silver (1991a) has emphasized the advantages of decisional guidance. According to his work, decisional guidance may help users to derive their own experts-like recommendations while enhancing their decision making skills. Similarly, Parkes (2013) shows that effects of providing decisional guidance included the increase of higher quality recommendations from novice decision makers, which led to an increase in decision quality overall. Another effect discussed by Montazmi et al (1996) is reducing the system restrictiveness and minimizing users' confusion.

Table 2 gathers findings of a collection of experiments from the literature discussing the effects of decisional guidance on DSS. Interestingly, these studies found significant contributions of decisional guidance to performance and quality. Its mechanisms can be seen as part of the evaluation criteria, the pillar of an evaluation method. This has been supported in (Rhee and Rao, 2008), where the authors are highlighting the importance of decisional guidance in DSS effectiveness, and suggesting the opportunity to use guidance typology as evaluation criteria for DSS.

When comparing findings from Table 1 and Table 2, we remark that decisional guidance desirable effects are present in the evaluation outcomes of the discussed experiments and the similarity between decisional guidance and criteria defined by

Adelman (1992) as "Evaluation criterion refers to an objective list that adds value to, and should be achieved by, a system".
The identification of evaluation criteria is one of the pillars of every evaluation process; it is also a guide throughout the development project.
Since decisional guidance is a design tool involved in the development of DSS, high performance is expected when it is correctly used. What matters is not the efficacy of decisional guidance, but the need and capability for evaluation of the DSS using a decisional guidance.
Taking into consideration the similarities between decisional guidance elements and evaluation criteria and the fact that they cover the whole decision making process (system usability, decision quality, user experience…) we can formalize decisional guidance into a source of criteria in the perspective of determining the decision value of a DSS.

TABLE 2
EMPIRICAL STUDIES ON DECISIONAL GUIDANCE FOR DSS

Study	Guidance Effects on DSS
Mahoney et al. (2003)	Improve Accuracy and decision-making time
Parikh et al. (2001)	Improve decision quality Increase user satisfaction Shorten time spent on decision making
Montazemi et al. (1996)	Increased performance
Lankton et al. (2012)	Reduced complexity
Parkes (2013)	Suggestive guidance to improve persuasiveness
Silver (2006)	Improved performance User learning Decision Quality
Gregor and Benbasat (1999)	Performance Learning Perception of the system
Gönül et al. (2006)	User satisfaction Performance
Shen et al. (2012)	Quality Better user experience
Antony et al. (2005)	Performance Usability
Mahoney et al. (2003)	Accuracy Response time

3.1 Typology of decisional guidance

The literature suggests a classification of decisional guidance into eight dimensions grouped in table 3: Target, directivity, modes, invocation styles and timing, the categories of explanations, content type, presentation format and provision mechanism. The main goal of the typology is to provide a common set of characteristics to describe types of guidance applicable for all, excluding the content of the described guidance (Morana et al., 2014).
Target was introduced by Silver (1991a, 1991b, 1996). It consists of choosing functional capabilities and using functional capabilities of a system. It helps users choosing between and interacting with a system's capabilities.
There are three types of **Directivity:** informative guidance "provides pertinent information that enlightens the user's choice without suggesting or implying how to act", suggestive guidance "makes explicit recommendations to the user on how to exercise his or her discretion" (Silver, 2006), and a mix of both types: the quasi-suggestive guidance "that does not explicitly make a recommendation but from which one can directly infer a recommendation or direction" (Silver, 2006).
The guidance **Mode** can be predefined (prepared by the system designer and is static), dynamic (learned from the user and generated by the system on-demand) and participative (enables the user to actively decide which information is needed and/or desired) (Wang and Benbasat, 2013).
The **Invocation style** describes how the guidance is started and delivered to the user (Silver, 2006): user-invoked, automatic and intelligent.
Regarding the **Timing** of guidance, it refers to the time when the guidance is provided to the user before, after or during a specific activity.
The **Format** of guidance can be either plain text or a multimedia object, designed to deliver messages or explanations to the user.
The guidance **intentions** can be the clarification of a perceived anomaly, the supply of extra knowledge and the facilitation of learning from the system (Gönül et al., 2006). A fourth characteristic is motivated by the literature on recommender systems (Wang and Benbasat, 2013).
Expertise is a key factor moderating the effectiveness of guidance; therefore, **Audience** guidance is categorized into Novices and experts (Morana et al., 2014).

4 A GLOBAL EVALUATION FRAMEWORK BASED ON DECISIONAL GUIDANCE

Forgionne (2000) developed a hierarchical model where the decision value is the result of both process and outcome effectiveness. Outcome is set by organization performance and decision maker maturity, and process support is prescribed by phase and step proficiency, personal efficiency, and personal productivity.
To support His findings, the author used an AHP (Analytic hierarchy process) method, where the problem is separated into a hierarchy of interrelated decision elements. The main evaluation elements (process and outcome) are placed in the

top, detailed criteria variables in the middle and the compared alternatives are at the bottom. The weights are attributed to

TABLE 3
TYPOLOGY OF DECISIONAL GUIDANCE (MORANA ET AL, 2014)

Categories	Characteristics			
Target	Choosing Functional capabilities		Using functional capabilities	
Directivity	Suggestive	Quasi-suggestive	Informative	
Mode	Predefined	Dynamic	Participative	
Invocation	Automatic	User-invoked	Intelligent	
Timing	Prospective	Concurrent	Retrospective	
Format	Text	Image	Animation	Audio
Intention	Clarification	Knowledge	Learning	Recommending
Audience	Novices		Experts	

the variables based on a rating system.
The AHP model is illustrated in figure 2. where the effectiveness of a DSS is a combination of Outcome value and process efficiency. Outcome is derived from organization performance and decision maker maturity while the process support is prescribed by phase and step proficiency, personal efficiency, and personal productivity.
Within these classifications, many measures can be used as evaluation variables. The alternatives in this case are illustrating the different scenarios compared to the DSS: another tool, and / or the process without DSS.
It is possible to assign the same or different weights to each assessment variable for each support tool. In completely impartial scheme, each variable would receive an equal weight, and each tool would have the same weight.
By aggregating the estimated weights through the hierarchy, the evaluator will obtain an overall rating for each provided support tool

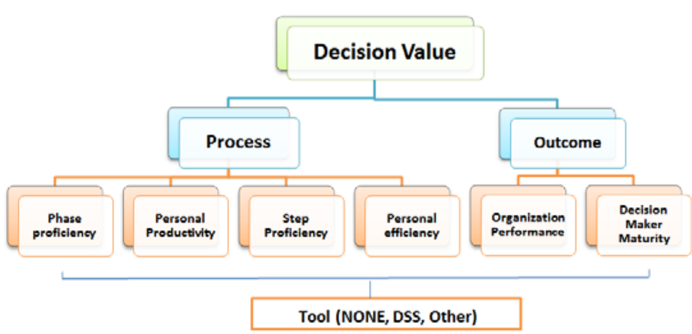


Fig. 2. Decision Value Hierarchy

The overall criterion ratings then provide a basis for identifying decision value from the provided support tool. Highly effective tools will receive the largest decision values (Forgionne, 2000).

Validation was made through an evaluation experiment with two major inputs: a database and a model-base. The database contains the outcome and process measures relevant for the decision situation and user-specified weights for the variables and support tools. Whereas the model-base contains the decision hierarchy as set out in Figure 2 and the AHP methodology.

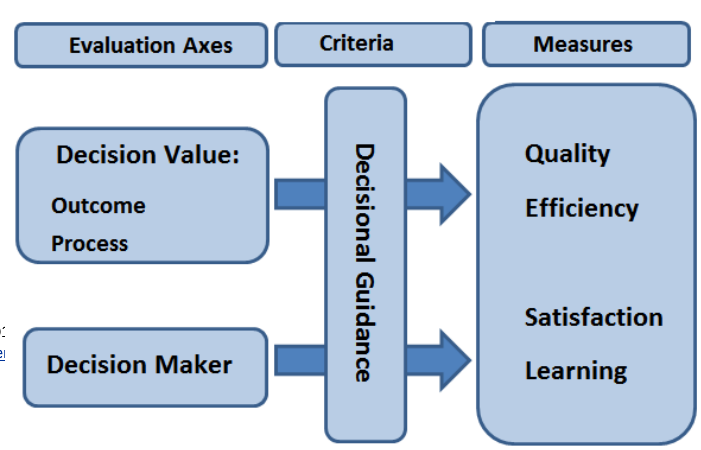
The DSS would use the operational model to automatically perform the AHP computations needed to simulate DSS effectiveness. Results would then be displayed on preprogrammed forms desired by the decision maker.

Such a model can be estimated through the analytic hierarchy process (AHP), or with alternative methodologies (such as multi-attribute utility theory, machine learning...). Moreover, the DSS evaluation model can be delivered to the evaluator in a relatively transparent manner through a decision support system.

The output of the evaluation processing are effectiveness forecasts and reports including : outcome projections of both organization performance and decision maker maturity assessments, Phase and step ratings along with personal ciency and productivity measures and the overall decision value of the DSS.

A derived evaluation framework

DSS should be evaluated against their contributions to improving the outcomes from, and the process of, decision making, along with the impact on the decision maker. In the light of the proposed model by Forgionne (2000), validated through several experiments (Healthcare, small business…) and findings of the research model, it has been demonstrated that for any successful global multi-criteria evaluation of DSS, we should involve two important components: the decision value, and the decision maker.
The decision value is issued from the combination of both decision outcome and the decision making process efficiency (Parikh et al., 2001). The decision maker satisfaction has been added to the hierarchy described above, but the user learning and performance improvement has been neglected in the literature.
We came to extend the existing evaluation model by adding another branch to this hierarchy representing the decision maker, to produce three separate areas of evaluation: Decision outcome, decision making process and Decision maker.



Based on the findings of Table 2 and this model, the second level of the hierarchy of DSS effectiveness (and decisional guidance effectiveness) should be evaluated on four axes:
(1) Decision quality, (2) decision-making efficiency, (3) user learning and (4) user satisfaction.
The model is illustrated in Fig 3. Decisional guidance (criteria) is used to evaluate Decision outcome on quality, decision making process on efficiency and Decision maker experience on satisfaction and learning.
Decisional guidance can provide the steps of the evaluation and the criteria through the implementation of the typology discussed earlier: Target representing system capabilities, Directivity and recommendations provided to the use, the Mode and user involvement in the guidance, decision process duration, interface formats, Audience adaptation…

Fig. 3. A global Model for DSS evaluation

This model can be widely used over various types of DSSs for a range of combinations of domain and technology. The evaluation is based on four measures: decision quality, efficiency of decision-making process, decision-maker's satisfaction and user's learning.
This approach helps the interested parties who are involved in evaluation to draw a big picture associated with the evaluation of their own domain-technology-specific DSS. Moreover, it can create the link between design requirements and evaluation process, and then be used to assess the outcomes of DSS development and usability.
Multiple-criteria DSS evaluation models can be useful in conducting a reconciliation and in providing a consistent basis for future studies on DSS effectiveness.

Conclusion

This paper has discussed the evaluation of decision support systems using decisional guidance as a source of evaluation criteria. Currently, more-specific DSSs combined with technology or analytical models are being developed to meet the specific needs of certain industries. This trend towards specialization leads to the need for a framework for a general evaluation scheme that can be applied to more-specific DSSs. Improved performance outcomes are a result of appropriate combinations of individual, task and technology factors. A comprehensive understanding of effective decision support requires consideration of technology design, as well as the fit between the individual and the task.

The literature of the evaluation approaches, pointed on the several criteria that can determine the efficiency and effectiveness of a DSS such as system utility, usability, interestingness, quality and outcome. In the same perspective, it has been proved that decisional guidance, as a design tool, is contributing to the same set of criteria a system should provide. We then focused on the effectiveness of decisional guidance in DSS. Providing decisional guidance helps novice decision makers produce an expert like recommendation from a DSS, and receiving an expert like recommendation from a DSS improves the quality of the decision outcome.

The discussed model of DSS evaluation focuses on what to evaluate. As measurement variables, it proposes decision (outcome) quality, the efficiency of the decision-making process, the decision-maker's satisfaction and learning, while using decisional guidance as a base for evaluation. The verification of the old model, through experiments, has been made by the mean of an AHP model hierarchy, organizing the evaluation process to combine scores of different variable levels, with respect to their weights, to form a final score and determine the effectiveness of a DSS. Further research is planned to put the new model into verification. Additional work will be required to develop and empirically test: evaluation outcome and process measures, decision outcome and value functions, and estimation methodologies. A successfully tested evaluation model then can become a standard for DSS effectiveness studies, and a tested evaluation DSS can serve as the normal delivery mechanism for the model.

References

Adelman, L. (1992) Evaluating decision support and expert systems, Wiley.

Antony, S.; Batra, D.; and Santhanam, R (2005). The use of a knowledge-based system in conceptual data modeling Decision Support Systems, 41, 1, 176–188.

Arvai J.L & Froschauer A. (2010) Good decisions, bad decisions: the interaction of process and outcome in evaluations of decision quality, Journal of Risk Research,13:7, 845-859.

Ben Ayed E. & Ben Ayed M. (2016) A quality model for the evaluation of decision support systems based on a knowledge discovery from data process, Journal of Decision Systems, 25:2, 95-117.

Bharati, A. Chaudhury (2004), An empirical investigation of decision making satisfaction in web-based decision support systems, Decision Support Systems 37 ,187–197.

Boukhayma K., Elmanouar A. (2015) Evaluating Decision support systems: A literature overview in: Proc. of the 15th conf. on Intelligence Systems Design and Applications, Dec.2015, pp 404-408.

Eierman M. A., Niederman F., Adams C. (1995), DSS theory: a model of constructs and relationships, Decision Support Systems 14 1995) 1–26

Forgionne, G. (2000). Decision-Making Support Systems Effectiveness: The Process to Outcome Link. Information Knowledge-Systems Management 2.

Forgionne G., Mora M., Gupta J., Gelman O. (2005), "Decision-Making Support Systems", Encyclopedia of Information Science and Technology, Hershey, PA, Idea Group.

Gönül, M.S., Önkal, D. & Lawrence, M. (2006), "The effects of structural characteristics of explanations on use of a DSS", Decision Support Systems, Vol. 42 No. 3, pp. 1481–1493.

Gregor, S. and Benbasat, I. (1999), "Explanations from Intelligent Systems: Theoretical Foundations and Implications for Practice", MIS Quarterly, Vol. 23 No. 4, pp. 497–530.

Holsapple C., Whinston A., (1996) Decision Support Systems: A Knowledge-based Approach, West Publishing Company.

Kirakowski, J. and M. Corbett (1990), Effective methodology for the study of HCI. North-Holland.

Kohli, R., and Devaraj, S. (2003). Measuring Information Technology Payoff: A Meta-Analysis of Structural Variables in Firm-Level Empirical Research. Information Systems Research, 14(2),

Lankton, N.K., Speier, C. & Wilson, E.V. (2012), "Internet-based knowledge acquisition: Task complexity and performance", Decision Support Systems, Vol. 53 No. 1, pp. 55–65.

Mahoney, L.S., Roush, P.B., & Bandy, D. (2003) An investigation of the effects of decisional guidance and cognitive ability on decision-making involving uncertainty data. Information and Organization, 13, 2, 85–110.

Montazemi, A.R., Wang, F., Nainar, S.M.K., and Bart, C.K. (1996) "On the effective-

ness of decisional guidance," Decision Support Systems (19).
Mora M., Phillips-Wren G. & Wang F. (2014) An Integrative Evaluation Framework for Determining the Value of Group Decision Support Systems, Engineering Management Journal, 26:2, 24-38.
Morana S., Schacht S., Scherp A. & Maedche A. (2014). Conceptualization and Typology of Guidance in Information Systems. Working Paper Series in Information Systems No. 7. University of Mannheim.
Parikh M., Fazlollahi B., Verma S. (2001), The effectiveness of decisional guidance: an empirical evaluation, Decision Sciences 32 (2), 303–331.
Parkes, A. (2013) "Persuasive Decision Support: Improving Reliance on Decision Aids," Pacific Asia Journal of the Association for Information Systems: Vol. 4: Iss. 3, Article 2.
Phillips-Wren, G., Mora, M., Forgionne, G., & Gupta, J. (2009). An Integrative Evaluation Framework for Intelligent Decision Support Systems. European Journal of Operational Research, 195, 642–652.
Phillips-Wren G., Mora M., and Forgionne G. (2010) Assessing Today: Determining the Decision Value of Decision Support Systems.
Pohl, J. (2008). Cognitive Elements of Human Decision Making. In G. Phillips-Wren, N. Ichalkaranje, and L. Jain (Eds.), Intelligent Decision Making: An AI-Based Approach (pp. 41–76). Berlin: Springer.
Pomerol, J. C., & Adam, F. (2008). Understanding Human Decision Making – A Fundamental Step Towards Effective Intelligent Decision Support. In G. Phillips-Wren, N. Ichalkaranje, and L. Jain (Eds.), Intelligent Decision Making: An AI-Based Approach (pp. 3–40). Berlin:Springer.
Rhee C., Rao. H. R. (2008). Evaluating Decision Support Systems. Handbook on Decision Support Systems 2. Springer.
Sharda R., Barr S.H. & McDonnell J.C. (1988), Decision support system effectiveness: a review and an empirical test, Management Science 34 (2) 139–159P.
Shen, M., Carswell, M., Santhanam, R. & Bailey, K. (2012), "Emergency management information systems: Could decision makers be supported in choosing display formats?", Decision Support Systems, Vol. 52 No. 2, pp. 318–330.
Shim, J.,Warkentin, M., Courtney, J., Power, D., Sharda, R., and Carlsson, C. (2002). Past, Present and Future of Decision Support Technology. Decision Support Systems, 33(2).
Silver, M. (1991 a) "Decisional Guidance for Computer-Based Decision Support" MIS Quarterly (15:1)
Silver M. (1991 b), Systems That Support Decision Makers: Description and Analysis. Chichester: Wiley.
Silver M. (2006), Decisional Guidance Broadening the Scope Human-Computer Interaction and Management Information Systems: Foundations. Advances in Management Information Systems, Volume 5 Armonk, NY: M.E. Sharpe.
Silver M. (2008). On the Design Features of Decision Support Systems: The Role of System Restrictiveness and Decisional Guidance. Handbook on Decision Support Systems 2. Springer.
Silverman, B., Normoyle, A., Kannan, P., Pater, R., Chandrasekaran, D., and Bharathy, G. (2008). An Embeddable Testbed for Insurgent and Terrorist Agent Theories: InsurgiSim. Intelligent Decision Technologies Journal, 2(4).
Simon, H. A. (1990). The New Science of Management Decision. NewYork, NY:Harper and Row.
Sojda R.S. (2004). Empirical Evaluation of Decision Support Systems: Concepts and an Example for Trumpeter Swan Management.
Speier C. (2006). The influence of information presentation formats on complex task decision-making performance. Int. J. Human-Computer Studies 64 (2006) 1115–1131.
Swink M., Speier C. (1999), Presenting geographic information: effects of data aggregation, dispersion, and users' spatial orientation, Decision Sciences 30 (1) (1999) 169–195.
Todd, P. and Benbasat, I. (1991), "An Experimental Investigation of the Impact of Computer Based Decision Aids on Decision Making Strategies", Information Systems Research, Vol. 2 No. 2, pp. 87–115.
Turban, E., and Aronson, J. (1998). Decision Support Systems and Intelligent Systems. Upper Saddle River, NJ: Prentice-Hall.
van Bruggen G.H.,Smidts A.,Wierenga B. (1998), Improving decision making by means of a marketing decision support system Management Science 44 (5) 645–658.
Wang, W. & Benbasat, I. (2013), "A Contingency Approach to Investigating the Effects of User-System Interaction Modes of Online Decision Aids", Information Systems Research, Vol. 24 No. 3, pp. 861–876.