Preface

Decision making support systems (DMSS) are information systems designed to interactively support all phases of a user's decision making process. There are various notions about all aspects of this definition. They can be for individual, or group usage. Support can be direct or indirect. The decision making process can be viewed in various ways. User-computer interaction can have a variety of dimensions. The information system offering the support can involve many technologies drawn from several disciplines, including accounting, cognitive science, computer science, economics, engineering, management science, and statistics, among others.

Because of the various perspectives and dimensions involved in decision making support, the field has evolved in a variety of directions. These directions have offered different focuses and contributions. While being effective and beneficial, this disparity has created much confusion about the theoretical basis, architectural form, support mechanisms, design and development strategies, evaluation approaches, and managerial and organizational aspects of decision making support systems. This book, which we have titled *Decision Making Support Systems: Achievements, Trends and Challenges for the New Decade*, is an attempt to alleviate some of the confusion.

Thus, this book aims to demystify DMSS by considering various phases involved in the development and implementation of them. The book's mission is to present the core and state-of-the-art knowledge about decision making support systems (DMSS). In the process, we hope to: (a) provide a compendium of quality theoretical and applied papers on DMSS, (b) help diffuse scarce knowledge about effective methods and strategies for successfully designing, developing, implementing, and evaluating of DMSS, and (c) create an awareness among academicians and practitioners about the relevance of DMSS in the current complex and dynamic management environment.

The presentation is divided into five sections. In the first section, labeled *Foundations and Architectures of DMSS*, we present the theoretical basis for decision making support and the architectures that have been proposed to deliver the theory in practice. There are four chapters in this first section.

In chapter 1, the main architectures of DMSS developed during the last 15 years are presented and their advantages and disadvantages for supporting the decision making process are analyzed. Because none of the stand-alone DMSS architectures supports the entire process in an integrated and complete manner, an integrated architecture is proposed and discussed. Implications of DMSS architec-

tures for researchers and practitioners for leading to better design, development, and robust implementation of DMSS are finally suggested.

Chapter 2 discusses a multidimensional framework for categorizing DMSS, originally proposed by Power. This framework is based on four characteristics: 1) the dominant component and driver of decision support, 2) the targeted users, 3) the specific purpose of the system, and 4) the primary deployment technology. With this framework, researchers and practitioners can improve their understanding of DMSS and can establish a common framework for classification and discussion.

A special architecture of DMSS, called spatial decision support systems (SDSS), is analyzed in chapter 3. Spatial applications represent an area of information technology (IT) application with a significantly different history from the other DMSS discussed in this book. However, the distinct contribution of SDSS to decision making is the ability of these systems to store and manipulate data based on its spatial location. SDSS is useful in a wide range of government and business activities. Untapped potential uses to enhance the decision making process are suggested finally.

The last chapter of this section, chapter 4, endeavors to provide a technical definition of DSS relying upon human decision making. It is argued that although there are good functional definitions of what DSS should do, an understandable definition involving human reasoning is still lacking. Therefore, this chapter attempts to bridge the gap between human reasoning and the understanding and design of DSS. The chapter first presents a description of the human process of decision making. A semiformal definition of DMSS is then developed and finally a brief discussion about DSS architecture is analyzed. The ultimate goal of this chapter is paving the way to better understanding and design of future DSS.

The second section of the book is called *Applications of DMSS*. As the label indicates, this section presents new and unique applications of the decision making support system concept. Six chapters detail these new DMSS applications.

In chapter 5, a real case of a DMSS to control routes of a regional railway system is presented. Competitive pressures in all systems of transport for passengers and goods require improved and effective use of all available resources to keep service reliability and availability, which ultimately have a strong impact on the quality perceived by users. Thus, the development of DMSS for this type of scenario is especially interesting. This chapter reports design issues and implementation experiences gained during its development. It also shows that DMSS are useful tools for mission-critical online processes.

Another real application of a DSS in the context of urban transportation, called *Navigate UTOPIA,* is reported in chapter 6. This area is particularly well suited to be supported by a DMSS through a multi-criteria approach, given the complexity and interaction involved with a series of economic, ecological, social, and political subsystems and the large number of stakeholders involved. In addition to the realized capabilities of *Navigate UTOPIA*, the chapter also focuses on the user behavioral issues related to its development. Learned lessons about the intense inter-

action with potential DSS users during the DSS construction phase, particularly when these include stakeholders with limited technical training, are discussed.

Chapter 7 describes the development of an expert support system oriented to quality management for a regional bank. This chapter shows that expert systems technology is still useful. Its technical construction is possible through a structured development process. The DMSS assists the teams to determine which problems to address and what data to collect in order to incrementally improve the business processes of the bank. For that reason, the DMSS provides decision support, interactive training and expert advice.

In chapter 8, a specific DMSS tool for the creation of guidelines for better DMSS in the domain of health informatics is reported. For that reason, this chapter presents an extended ontology for a DMSS founded on related research in information systems and artificial intelligence and on several case studies in health informatics. The ontology explicates relevant constructs and presents a vocabulary for a DMSS. It also emphasizes the need to cover environmental and contextual variables as an integral part of decision support systems development and evaluation methodologies. With the inclusion of specific domain, application, and knowledge aspects, it is claimed that more successful systems could be developed. However, other complications arise. This chapter discusses these complications and their managerial and practical implications.

An exploratory analysis of how knowledge management (KM) practices can enhance the decision-making process in pharmaceutical firms is reported in chapter 9. The complexity of the pharmaceutical industry, from the hard science of drug research and development to the psychology of marketing, places special decision making demands on managers. Since knowledge is considered a core resource to make good decisions, and pharmaceutical firms rely on innovation and collaboration activities that are knowledge intensive activities, then, KM becomes an essential practice for DMSS development.

Chapter 10 reports a case study of how DMSS support a leader organization in the entertainment industry. The core advanced IT of the DMSS presented is data warehousing (DW), which could be considered to be the most important development in decision support over the last decade. DW is being used to support many important organizational strategies and initiatives, such as the balanced score card, electronic commerce (both B2C and B2B), and customer relationship management (CRM). CRM is designed to attract new customers, enhance relationships with existing customers, and reduce customer attrition. This case describes how the organization has deployed DW and DMSS to support their business strategy. Special attention is given to the use of IT to support "closed loop marketing." The impacts of IT-based initiatives are discussed. Finally future directions and lessons learned are given.

The third section of the book is titled *Advanced IT for DMSS*. This section presents state-of-the-art information technologies that have been developed to improve the efficiency and effectiveness of decision making support systems. Some

of the technologies are variations on existing hardware and software concepts. Others are new, unique, or innovative. These advanced IT developments are offered in six (6) separate chapters.

In chapter 11, a large-scale and multiyear project in the military context based on multiagent systems, called *SENTINEL*, is described. It was designed to computerize the strategic and tactical planning processes of the U.S. Coast Guard (USCG). This large-scale project required the creation of several distributed decision support systems (DDSS) for human participants acting at different levels of the USCG hierarchy. This chapter describes the objectives, the peculiarities, and the constraints of the task environment, as well as the solution to some problems that are fundamental and ubiquitous in many real-time, spatially and temporally distributed multiagent systems.

In chapter 12, a conceptual knowledge warehouse architecture is posed for the extraction, storage, analysis and understanding of explicit knowledge. Knowledge warehouses (KW), similar to the data warehouses, could provide knowledge and support to the entire enterprise decision making process. The proposed KW architecture consists of an object-oriented knowledge base management system module (OO-KBMS), a knowledge analysis workbench, and a communication manager. The proposed KW architecture is unique in that it proposes support for all four phases of the knowledge spiral in a decision support system, especially in model-based decision support. Finally, practitioner and research implications are reported.

Chapter 13 reports a technique to develop expert systems (ES) called ripple down rules (RDR). This chapter shows that an ES can generate negative perceptions in the practitioner and academic community. While ES had shortcomings, there are successes and ES research is alive. A reason for the limited use of ES is reported as the high complexity for its development and in particular due to the knowledge acquisition phase. Consequently this chapter describes a knowledge representation and acquisition technique, i.e., RDR, that tackles head-on the limitations of first-generation ES while avoiding some of the new problems introduced in second-generation ES. Finally, emerging trends and future directions of ES research are given.

A general information framework of e-management for knowledge-based modeling of customer responsive systems is reported in chapter 14. This framework integrates intelligent information support, group decision making, and agreement modeling for a supply chain network. Through the proposed framework, it is possible to experiment with various types of behavior patterns that may emerge through interaction of virtual enterprise members and apply lessons learned in developing robust e-management models. Global firms that compete in a business environment based on complex collaborative relationships need frameworks to deploy adequately the underlying information technology infrastructure to support their business strategies. This chapter offers a conceptual mechanism for providing such support.

A new kind of DMSS based on synthetic characters is reported in chapter 15. Synthetic characters are intelligent agents able to show typical human-like behavior by means of natural language interaction. This chapter shows how a particular highly interactive kind of intelligent agent, i.e., the synthetic characters, can support the decision making process. It also discusses general characteristics of a decision making model and the architecture and processing flow of DEMON (DEcision-Making OrgaNizer), a decision support agent currently under development. Finally, research and practical implications are given.

In Chapter 16, a novel advanced IT approach is presented: the narrative-based information systems (NBIS) approach. Since DMSS are focused on improving the effectiveness of the decision making process and are based on the accuracy of the resulting information, the presentation language of a DMSS, a part of the user interface, is critical for successful DMSS operation. Narratives and stories could be incorporated to achieve greater meaning and understanding of the presentation language of a DMSS. A conceptual model of NBIS is examined and used to outline areas for further research. Finally, theoretical and practical implications for DMSS developments are discussed.

The fourth section of the book is called *Evaluation and Management of DMSS*. This section offers some new or innovative ways to evaluate the effectiveness of decision making support systems. This section also presents managerial issues that are created or resolved by the implementation of these systems. Four chapters are used to present the material.

Chapter 17 reports a conceptual scheme called the decision support systems research (DSSR) framework. The DSSR framework was developed to integrate theoretical constructs from various information systems areas into a coherent theme with the objective to improve the quality of the DMSS. This DSSR framework can be used as the basis for the identification and selection of a hierarchy of factors potentially affecting the quality of DMSS development. The DSSR framework is used in tandem with the generic software quality metrics framework specified in the IEEE Standard 1061-1992. The usage of these frameworks to identify system quality factors is demonstrated in the context of military research and development projects.

In chapter 18, a national-based descriptive study on the usage and practices of executive information systems (EIS) is reported. EIS have been widely used in multinational organizations located in highly developed nations. In emergent economies, their usage is still limited. This chapter reports the findings from a survey study conducted in an emergent economy country. Following the work line manifested in the preceding research, this chapter aims at undertaking a comparative analysis between the reported situation of EIS and the results obtained in similar descriptive studies.

Based on the Rockart's critical success factor (CSF) approach, chapter 19 puts forward a practical method to guide the development of executive information systems (EIS) in organizations. This method extends the current theory of EIS by

using the concept of the *dashboard of information* to show how an enterprise-wide approach to the development of more effective decision support for managers can deliver tangible benefits without requiring the time-consuming and single-decision focus of the traditional development methods. This method also attempts to leverage the latest computing technologies now available for the development of such systems, notably graphical user interfaces (GUI), data warehousing (DW) and OLAP. The proposed approach is illustrated by examples of dashboard developments, which show how managers should carry out the analysis and development of such a system in their own organizations, business units or functional areas.

In chapter 20, an extensive literature review of the main contributions and limitations of the factor-based (FB) and stage-based (SB) approaches conducted in the DMSS implementation research is presented. It is argued that despite the claimed benefits of stand-alone and integrated DMSS, the rate of implementation failures is still high. Therefore, in practice, the number of DMSS installed and adequately used has been far less than expected. Under the premise that DMSS implementation is a process of high complexity, it is claimed that FB and SB approaches must be complemented with other research approaches in order to capture the full complexity of the whole phenomenon. The authors propose the systems approach as this emergent research methodology. Finally, conclusions and directions for further research are given.

The fifth, and last, section is titled *Challenges and the Future of DMSS*. As the title suggests, this last section identifies key challenges for management, organizations, and other entities that are presented by decision making support systems. The section also discusses the main trends in DMSS research and practice. A unique feature of this last section is that it reports the opinions of leading DMSS researchers and practitioners regarding the challenges and opportunities that exist in the field.

Chapter 21 describes a study of how two advanced technologies, simulation and geographic information systems, can be integrated to support a critical complex management process like evacuation and emergency planning and management. The aim is to provide decision support for emergency prevention or mitigation, response and recovery. At present, this process widely relies on computer-aided emergency management systems which gather and analyze information and data on hazardous emissions, geological activity, meteorology, demography, and geography. Therefore, deployment of advanced IT for DMSS is attractive but it is also complex. This chapter identifies and analyzes the challenging issues faced in using the above two technologies. It focuses on the behavioral and decision making processes of the various players in the evacuation system, logistics, generating realistic scenarios for testing out contingency plans, and the validation of such computer-based decision support tools. Future trends in technology and the evolution of emergency planning and management processes are also discussed.

Based on Kant, Hegel, Locke and Liebnitz mental models, chapter 22 reviews the inquiring models with a view to provide an analytical framework for knowledge creating and sharing activities. Knowledge management (KM) has been identified

as a critical activity for decision-making, since it includes task solving activity which requires high-quality knowledge as input. This chapter provides a review of the KM concepts and perspectives, with an introduction to knowledge management systems (KMS) and related technologies. The importance of a knowledge base for knowledge management (KM) and knowledge sharing (KS) activities is illustrated for a hypothetical firm. Effective knowledge sharing or better knowledge utilization can result in increased organizational capabilities as defined by competitiveness, efficiency, competency, and creativity. Emergent DMSS based on KMS is finally suggested as a key research topic.

The last chapter of the book, chapter 23, attempts to summarize the achievements of decision making support systems and outlines the future opportunities and challenges. It does so by inviting and synthesizing the opinions of the experts in this exciting and emergent field of study. From this chapter, is it clear that DMSS have been useful in a variety of situations and have provided significant support to technical, managerial, and executive decision making efforts. This chapter also reports that while much has been accomplished in this field, considerable work still needs to be done, including the explicit consideration of the DMSS implementation issues in a global context.

We believe that the book will be a comprehensive compilation of DMSS thought and vision. There is a thorough presentation on all phases of decision making support, newly reported applications in DMSS in a variety of areas, unique information technologies for improving DMSS design, development, and implementation, unique strategies for measuring DMSS effectiveness, and new methodologies for managing DMSS in practice. The presentation illustrates the concepts with a variety of public, private, societal, and organizational applications, offers practical guidelines for designing, developing, and implementing DMSS, offers measures to effectively evaluate and manage DMSS, and presents expert opinion about the future of DMSS.

Readers of the text will gain an understanding of, among other things: (a) decision making concepts in organizations, (b) DMSS types, (c) DMSS integration strategies, (d) ESS, IDSS, MSS, and DTS architectures, (e) intelligent agents, RDR-based expert systems, synthetic characters, NIBS and other innovative AI-based approaches, (f) system simulation, (g) DMSS system design and development, (h) DMSS effectiveness measurement, (i) organizational and management issues and impacts, (j) DMSS implementation barriers, and (k) future DMSS trends. Thus, this will facilitate the development and implementation of decision making support systems within any organization. It is hoped that the book will enable the business community to start benefiting more widely from this powerful technology.

This understanding of various phases of DMSS should benefit undergraduate and graduate students taking decision making support systems courses and practitioners seeking to better support and improve their organizational or individual decision making process. Hopefully, the book will also stimulate new research in DMSS by academicians and practitioners.