Preface

Decision support remains an active area of research and new methods and new application areas are regularly reported in the scientific literature. Building effective computerized Decision Support Systems (DSS) is possible and increasingly common. Understanding how to engineer various DSS and reuse components and methods promises to increase the likelihood of success. This volume of Advances in Decision Support System Technology is titled Engineering Effective Decision Support Technologies: New Methods and Applications. It includes 16 chapters.

Decision support technologies result from creating, combining, and modifying computing hardware and software components to solve decision problems, retrieve decision support information, and improve decision making processes. Decision support is a broad field of applications development and implementation. DSSResources.com defines a decision support system as “an interactive computer-based system or subsystem intended to help decision makers use communications technologies, data, documents, knowledge, and models to identify and solve problems, complete decision process tasks, and make decisions.” Decision support system is a general term for any computer application that enhances a person or group’s ability to make decisions.

Decision support systems engineering has been a research topic since Andrew Sage (1991) formalized and differentiated the content area. Engineering is not widely used to describe DSS development, but the concept and methods remain useful. Engineering is a “mindset” or way of viewing the world that brings a scientific perspective to DSS design. Perhaps future DSS designers need to focus more on engineering repeatable decision support solutions.

Sage uses the term decision support systems engineering to mean the systems engineering of decision support systems. Systems engineering relies on 1) design tools and techniques, 2) a systems design methodology, and 3) systems management cognitive tasks needed to produce a useful system.

Engineering is a more mature professional discipline than Information Systems or Computer Science. From an observer’s perspective, computer and systems engineering have evolved from industrial and electrical engineering. Reviewing curricula it seems systems engineering programs develop and reinforce problem-solving, analytic thinking, and mathematical modeling. In general, an engineer starts with an abstract idea and creates a real instance of the idea.

Sage defines systems engineering “as the need identification, architectural specification, design, production, and maintenance of functional, reliable, and trustworthy systems within cost and time constraints” (Sage, 1991, p. 9).

Engineers create new technology artifacts. A decision support engineer combines structural components and designs new architectural components to expand the functionality of a specific instance of a DSS. A method is used to customize the system and fit it to organization requirements. The resulting
system is specific to an organization and its planned usage. Imagine a familiar physical artifact like a bridge. An engineer designs specific bridges that connect specific physical locations. All bridges have similarities and the engineered design of two bridges may be almost identical, but the actual bridge is at a specific place serving a specific need. Engineering DSS has similarities to any recurring engineering design and development task.

So what is the impediment to building effective DSS? Is it rapid technology change? Is it poorly defined concepts? Is it a lack of research and critical evaluation? Is it a failure to systematize our experiences? Or all of the above?

IT staff develop DSS that fail to meet specifications when one or more of five problems occur: 1) the development method used is inappropriate, 2) the original abstract idea was impractical, 3) technology change made the specifications obsolete, 4) the specifications used immature or emerging technologies, and 5) the problem is misidentified or poorly understood. Some argue DSS are frequently designed haphazardly and that systems engineering tools, methods and approaches reduce problems that lead to failure.

The major purpose of the systems engineering design and development life cycle is to overcome problems and increase DSS effectiveness. DSS effectiveness refers to answering the question “Is the DSS accomplishing its intended purpose?” (cf., Sage, 1991, p. 201). A decision support engineer learns to apply tools, methods, and manage development processes.

Engineering and Information Systems professionals continue to apply scientific, human factors, and practical knowledge to create and design integrated hardware and software technology solutions to assist decision makers. Applying the concept of “engineering” to building DSS adds a dimension of system and method to our understanding of what is necessary to successfully build more effective DSS.

Researchers continue to study the tools, methods, and management issues associated with building and engineering DSS, as well as the specific applications that decision support analysts and systems engineers develop. A critical evaluation of practice is important to increasing the likelihood of success. Finally, systematizing our experiences provides organized knowledge to help educate the next generation of developers. Research and evaluation of practice can lead to engineering more effective DSS and better use of decision support system technologies.

The 16 chapters in this volume discuss contemporary issues related to modeling and designing systems and provide examples of specific technologies and discuss emerging areas for deploying decision support. The first six chapters deal broadly with methods and the remaining ten chapters discuss applications and case studies. The authors of chapters in this volume are from 10 countries on 4 continents. The following paragraphs briefly summarize the chapters in the volume.

Chapter 1 is by El-Gayar, Deokar, and Tao from Dakota State University in the United States and titled “DSS-CMM: A Capability Maturity Model for DSS Development Processes.” They note that there are many DSS development methodologies, but argue a gap exists in terms of the ability to provide a holistic conceptual structure for improving the management and development of decision support systems. Existing methods fail to capture and share understanding of key DSS development processes and provide limited guidance for DSS development and process improvements. They reviewed the literature on maturity models over the past two decades. Their maturity model identifies DSS development processes and capability levels. They consider DSS-CMM the first maturity model specifically targeting DSS development and they argue model can help managers devise process improvement initiatives to address limitations with existing practices.

Mendibil, Hird, McCabe, and Turner from the United Kingdom summarizes several system development methodologies. Their review found that no one methodology took into account all the business related considerations they had identified. The authors conclude there is a gap in current research and a real need for a methodology that addresses the considerations they identified.

Chapter 3 also focuses on methodology. The chapter “IDSSE-M: A Software System Engineering Methodology for Developing Intelligent Decision-Making Support Systems” was written by Mora, Wang, Gelman, and Klajic. This international research team notes Decision-making Support Systems (DMSSs) have been traditionally designed and built using one of three methods: 1) the Waterfall method, 2) Prototyping-Evolutionary design, or 3) an Adaptive approach. The authors argue that while such approaches have guided DMSS developers, from a Software Systems Engineering (SSE) viewpoint, such approaches cannot be considered well-defined methodologies. The article reports an initial empirical evaluation of IDSSE-M, a free-access methodology for designing and building Intelligent Decision Support Systems. IDSSE-M extends and adapts Turban and Aronson’s DSS Building Paradigm and Saxena’s Decision Support Engineering Methodology.

Chapter 4, “Ontology Engineering: The ‘What’s,’ ‘Why’s,’ and ‘How’s’ of Data Exchange,” is authored by Easton, Davies, and Roberts, all from the University of Birmingham, UK. The authors provide an overview of ontology for engineers, describing what ontology is and why it is useful, before going on to introduce key technologies and review the engineering methodologies that can be used in ontology development. Easton et al. argue that for large-scale complex systems such as railways, electricity grids, and gas distribution networks, it is often necessary to combine information from numerous different condition monitoring systems. They note that given the large amounts of data produced every day and problems with data models that the data may be used incorrectly. To help deal with this concern, the authors provide an introduction to the field of Ontology, an emerging technology that allows the exact “meaning” of an item of data to be described in a way that can be interpreted by computers.

Chapter 5, “Using Social Network Analysis to Support Collective Decision-Making Process,” was authored by Shum, Cannavacciuolo, De Liddo, Iandoli, and Quinto. They argue a better method is needed for organizing knowledge. To address limitations in current methods and to foster collective decision-making around complex and controversial problems, a new family of tools is emerging to support more structured knowledge representations known as collaborative argument mapping tools. Online collaborative argument mapping tools are designed to help diverse and geographically dispersed groups to systematically explore, evaluate, and come to decisions concerning complex problems. They argue that online collaborative argumentation has the unique feature of combining knowledge organization with social mapping and that such a combination can provide interesting insights about the social processes activated within a collaborative decision making initiative. In particular, the authors investigate how Social Network Analysis can be used to analyze a collective argumentation process to study the structural properties of the concepts and social networks emerging from users’ interaction. They used an online platform designed to support collaborative argumentation called Cohere to study two use cases.

Chapter 6 by O’Leary is the last of six more general method chapters. The title is “Social Media in DMSS System Development and Management.” The chapter surveys and extends the use of social media technologies as part of Decision Making Support System (DMSS) development and management. O’Leary investigates how social media technologies, such as wikis, blogs, micro-blogs, and tagging, have been and can be used to facilitate development and management of DMSS through communication and collaboration. He suggests based on a review of going beyond simply communication and collaboration and using social media content to help capture project history, facilitate documentation development, and
provide insights into project development. Domain-based characteristics of the text are investigated to discover meaning in social media content. The chapter conclusions are based on empirically analyzing publicly available social media content.

Chapter 7, “Automated Diagnosis through Ontologies and Logical Descriptions: The ADONIS Approach,” was written by Rodríguez-González, García-Crespo, Colomo-Palacios, Gayo, Gómez-Berbís, and Alor-Hernández. This chapter applies a specific engineering design method to the health care domain. The authors argue the use of Semantic Technologies for Automated Diagnosis could leverage the potential of current solutions by providing inference-based knowledge and support for decision-making. The chapter presents the ADONIS approach, which uses ontologies and underlying logical mechanisms to automate diagnosis for real-world data scenarios. An ontology is defined as “a formal and explicit specification of a shared conceptualisation.”

Chapter 8 by Jankovic and Zaraté is titled “Discrepancies and Analogies in Artificial Intelligence and Engineering Design Approaches in Addressing Collaborative Decision-Making.” They note the trend toward more collaborative decision-making and a need to provide computer support. Their study examines the discrepancies and similarities in addressing supporting collaborative decision making in two scientific fields: 1) artificial intelligence and 2) engineering design. They argue these two fields have different considerations and approaches to decision-making support. This paper compares two decision support oriented research studies. The authors conclude the types of information identified in the case of collaborative decision-making support can be generalised to other decision contexts and situation.

Chapter 9, “Decision Support for Crisis Incidents,” was written by Power, Roth, and Karsten, colleagues at the University of Northern Iowa, USA. The chapter explores an application domain where engineered decision support is particularly important. Crisis incidents occur in both business and public sectors. This article focuses on non-routine incidents and explores uses of technologies for supporting crisis management tasks. A Crisis Incident Spiral of Decision Support helps identify useful decision support and information technologies. Additionally, a Crisis Incident Process/Decision Support Matrix categorizes processes of crisis planning, response, and management with decision support technologies. Ideally, the matrix helps organize and stimulate thinking about novel DSS applications. Not all crises are of equal magnitude and it is important to develop different computerized decision support for different types of crisis incident situations and organizations that must respond to those crises. Despite the challenges, the authors conclude we must persist in building and using decision support and information systems to help people in crisis planning, response and management.

Chapter 10, “Visualization-Based Decision Support Systems: An Example of Regional Relationship Data,” is by Sauter, Mudigonda, Subramanian, and Creely. They note decision makers are incorporating large quantities of interrelated data in their decision-making. Because of this change, DSS need to provide visualization tools to help decision makers glean trends and patterns that will help them design and evaluate alternative actions. They argue the literature does not provide sufficient guidelines for selecting among possible visualizations or their attributes. The chapter describes a case study of the development of a visualization component to represent regional relationship data. It addresses the specific information goals of the target organization, various constraints that needed to be satisfied, and how the goals were achieved via a suitable choice of visualization technology and visualization algorithms. The development process highlighted the need for specific visualizations to be driven by the specific problem characteristics as much as general rules of visualization. The chapter also includes lessons learned during the process and how these lessons may be generalized to address similar requirements.
Chapter 11 by Professors Escobar-Toledo and Martínez-Berumen at Universidad Nacional Autónoma de México is titled “Strategic Development of a Decision Making Support System in a Public R & D Center.” They assert making decisions about new technologies is a crucial activity to raise competitiveness, especially for technology organizations. This decision-making process requires the use of information technology tools. The chapter proposes integrating new elements into the IT strategy, considering interactions with other organizational functions, and defining an implementation and transition plan. The authors propose a theoretical framework intended to foster alignment between organizational strategy and information systems. The analysis and prescriptions are based on a case study of a Mexican Public R&D Center that re-engineered its operating model using a systems approach.

Chapter 12, “Understanding Organisational Decision Support Maturity: Case Studies of Irish Organisations,” was written by Daly and Adam at University College Cork, Ireland. They argue that given the elapsed time since DSSs were first introduced, it is important to gauge the scope and quality of decision support provided to managers. Using Executive MBA students as informants about decision making in their organisations, the authors examined 10 case studies of Irish organisations to assess their maturity in terms of decision support usage. The assignment question asked informants to “Identify decisions made in your organisation, and identify the DSS which facilitate decision making for these decisions.” The findings indicate that, in the vast majority of firms, decision support is still not available to help manage in situations involving high levels of abstraction. The operational decision making level is still where DSSs are used most consistently across firms. Furthermore, this study illustrates that interviewing managers on the topic of decision-making is difficult.

Chapter 13, “Development and Application of a Spreadsheet-Based Spatial Decision Support System (SDSS),” by Oryspayev, Sugumaran, and DeGroote, a research team in Iowa, USA. They define Spatial Decision Support Systems (SDSS) as decision support tools used to evaluate complicated issues involving a spatial component. They note the use of SDSS has increased greatly over the last few decades especially in fields such as planning, natural resources management, and environmental science. Traditionally, SDSS have been developed with Geographic Information Systems (GIS) technology as a major component and used in application areas in which the use of GIS technology has been common. GIS software is often expensive and requires significant expertise, which can lead to under-utilization of GIS-based SDSS. In the chapter, they describe development of a freely available SDSS extension for Microsoft Excel, a common spreadsheet application. The purpose of the SDSS extension is to expand potential SDSS use to a wider potential audience for research, management, and teaching purposes.

Chapter 14 by Robinson and Amirtharaj from Bishop Heber College, India, is titled “Extended TOPSIS with Correlation Coefficient of Triangular Intuitionistic Fuzzy Sets for Multiple Attribute Group Decision Making.” The chapter extends the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) for solving multi-Attribute Group Decision-Making (MAGDM) problems under triangular intuitionistic fuzzy sets by using its correlation coefficient. In situations with Triangular Intuitionistic Fuzzy Numbers (TIFNs), some arithmetic aggregation operators have to be defined, namely the triangular intuitionistic fuzzy ordered weighted averaging operator and the Triangular Intuitionistic Fuzzy Hybrid Aggregation (TIFHA) operator. An extended TOPSIS model is developed to solve the MAGDM problems using a new type of correlation coefficient defined for TIFNs based on the triangular intuitionistic fuzzy weighted arithmetic averaging operator and the TIFHA operator. With an illustration, this proposed model of MAGDM with the correlation coefficient of TIFNs is compared with the other existing methods. TOPSIS is a logical decision-making approach and deals with the problem of choosing a solution from a set of candidate alternatives, which are characterized in terms of some attributes.
Chapter 15, “Hierarchical Database Model for Querying Economic Network Independence Distribution,” was written by Akinwale Adio Taofiki, University of Agriculture, Abeokuta, Nigeria. Taofiki argues the development of the Internet has been triggered numerous mutations in the visualization of actors in the Economic Network Independence Distribution (ENID) of goods. ENID software helps overcome the physical barriers of shop-floor space so a large variety of products can be offered to customers. Avoidance of expensive trade space allows suppliers to reduce price compared to those in the physical world. User-friendly and easy contact with the supplier of the goods make shopping very convenient. Despite these advantages of ENID, there is a need to develop better theories about how this system should behave in order to protect participants’ interests. The system employed a hierarchical database model using B-tree and pre-order algorithm to insert and traverse participant records for easy processing. N-level models were adopted to calculate each level and sub-level cluster commission. The implementation was carried out using C# and SQL. The application of the model permits the participants to query any information about ENID for on line real-time decision making.

Chapter 16 by Gradisar, Erjavec, and Tomat is a technical model-driven decision support case study titled “One-Dimensional Cutting Stock Optimization with Usable Leftover: A Case of Low Stock-to-Order Ratio.” The chapter describes a method for solving a one-dimensional Cutting Stock Problem with Usable Leftover (CSPUL) in cases where the ratio between the average stock and average order length is less than 3. The proposed method can solve general CSPUL where standard stock lengths, non-standard stock lengths, or a combination of both are cut in the exact required number of pieces. The solutions of sample problems are compared with other methods. A cutting stock application, as the authors note, can be a part of a decision support system.

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REFERENCE