

Integrated Series in Information Systems

Volume 37

Series editors

Ramesh Sharda

Oklahoma State University, Stillwater, OK, USA

Stefan Voß

University of Hamburg, Hamburg, Germany

More information about this series at <http://www.springer.com/series/6157>

Jason Papathanasiou • Nikolaos Ploskas •
Isabelle Linden
Editors

Real-World Decision Support Systems

Case Studies

Editors

Jason Papathanasiou
Dept. of Business Administration
University of Macedonia
Thessaloniki, Greece

Nikolaos Ploskas
Dept. of Chemical Engineering
Carnegie Mellon University
Pittsburgh, PA
USA

Isabelle Linden
Dept. of Business Administration
University of Namur
Namur, Belgium

ISSN 1571-0270 ISSN 2197-7968 (electronic)
Integrated Series in Information Systems
ISBN 978-3-319-43915-0 ISBN 978-3-319-43916-7 (eBook)
DOI 10.1007/978-3-319-43916-7

Library of Congress Control Number: 2016960674

© Springer International Publishing Switzerland 2016

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

*To the Euro Working Group on Decision
Support Systems coordination board and
members, for their continuous and inspiring
commitment on the promotion of the
discipline*

Foreword

Decision support systems (DSSs) appeared in the literature by the beginning of the 1970s. The first developed DSS was developed for executive managers using personal computers and was called executive information systems. Since this period, DSS evolved in several directions. The first proposed architecture of these systems was composed by a database management system, a model base management system, and a man-machine interaction module. The first step in the evolution of DSS was based on the introduction of knowledge in the architecture. A new module was added called the knowledge-based management system as well as an inference engine. From then on, due to a huge amount of data, the database management system evolved in line with research on data warehouses, for which the main concern is to find suitable data for the decision-maker. For the model base management system, a lot of research has been conducted including several kinds of models of real decision problems. These models are formulated in different ways like linear or constraint programming, decision rules, decision trees, etc. Nowadays, researchers on DSS are still very active and dynamic, and we can notice an evolution of the name; DSSs are also called in a more general way decision-making support systems (DMSSs). The number of international journals and international conferences on this topic is progressing every day. Recently, a new such journal, the *International Journal of Decision Support System Technologies* was created, published by IGI Global. This journal publishes selected papers organized in one volume per year including four issues composed of four papers. We can also mention the International Conference on Decision Support System Technologies organized annually by the Euro Working Group on Decision Support Systems. The conference attracts every year an international group of researchers, academics, and practitioners working on decision support systems. Topics covered by both the journal and the conference are, among others, context awareness, modeling, and management for DMSS; data capture, storage, and retrieval; DMSS feedback control mechanisms; function integration strategies and mechanisms; DMSS network strategies and mechanisms; DMSS software algorithms; DMSS system and user dialog methods; system design, development, testing, and implementation;

DMSS technology evaluation; and finally DMSS technology organization and management.

Nevertheless, this research would be without any actual interest if applications would not be developed and tested in real-life situations. The applications of DSS or cases of DSS are also very important and allow researchers to implement their architectures, models, and methodologies in real situations. These implementations are very valuable for the improvement of the DSS field. Indeed, the idea of this book, *Real-World Decision Support Systems – Case Studies*, including the application domains of the environment, agriculture and forestry, business and finance, engineering, food industry, health, production and supply chain management, and urban planning, is an excellent initiative. Research on the DSS discipline is still very promising and will be exciting for several decades to come.

Toulouse, France
June 2016

Pascale Zaraté

Preface

The number of papers regarding decision support systems (DSSs) has soared during the recent years, especially with the advent of new technologies. Indeed, if someone considers DSS as an umbrella term [1], the plurality of research areas covered is striking: from computer science and artificial intelligence to mathematics and psychology [3]. It is in this context that the editors of this book felt that there is a gap in the overall fabric; it was felt that too much attention has been given to theoretical aspects and individual module design and development. In addition, there have been many failures in information systems development; poor initial requirements analysis and design has many times led to a notable lack of success. Indeed, it seems that the DSS discipline is rather prone to this, tagging the development of such projects as risky affairs [2].

Moreover, decisions today have to be made in a very complex, dynamic, and highly unpredictable international environment with various stakeholders, each with his own separate and sometimes hidden agenda. Right into the center of the whole decision process is the decision-maker; he has the responsibility for the final decision and he will most probably bear the consequences. As there is no model that can integrate all the possible variables that influence the final outcome and the DSS results have to be combined with the decision-maker's insights, background, and experience, the system must facilitate the process at each stage rendering the user experience concept of great significance.

Bearing the above in mind, the rationale behind this edition is to provide the reader with a set of cases of real-world DSS, as the book title suggests. The editors were interested in real applications that have been running for some time and as such tested in actual situations. And not only that; unsuccessful cases were targeted as well, systems that at some point of their life cycle were deemed as failures for one reason or another. If the systems failed, what were the (both implicit and explicit) reasons for that? How can they be recorded and avoided again? The lessons learned in both successful and unsuccessful cases are considered invaluable, especially if one considers the investment size of such projects [4]. The overall and primary goal in each case is to point out the best practices in each stage of the system life cycle, from the initial requirements analysis and design phases to the final stages of

the project. The cases aim to stimulate the decision-makers and provide firsthand experiences, recommendations, and lessons learned so that failures can be avoided and successes can be repeated.

The authors of the chapters of this book were requested to provide information on a number of issues. They were asked to follow a certain chapter structure, and their work was rigorously peer-reviewed by the editors and selected reviewers from the DSS community. The cases are also presented in a constructive, coherent, and deductive manner, in order to act as showcases for instructive purposes, especially considering their high complexity. This book consists of one introductory chapter presenting the main concepts of a decision support system and 12 chapters that present real-world decision support systems from several domains. The first chapter by Daniel Power reviews frameworks for classifying and categorizing decision support systems, while it also addresses the need and usefulness of decision support system case studies.

Chapter 2 by Malik Al Qassas, Daniela Fogli, Massimiliano Giacomini, and Giovanni Guida presents the design, development, and experimentation of a knowledge-driven decision support system, which supports decision-making processes that occur during clinical discussions.

Chapter 3 by Anna Arigliano, Pierpaolo Caricato, Antonio Grieco, and Emanuela Guerriero proposes a method to integrate decision analysis techniques in high-throughput clinical analyzers. The proposed method is integrated into a clinical laboratory information system in order to demonstrate the benefits that it achieves.

Chapter 4 by Andrea Bettinelli, Angelo Gordini, Alessandra Laghi, Tiziano Parriani, Matteo Pozzi, and Daniele Vigo is about a suite of two decision support systems for tackling network design problems and energy-production management problems.

Chapter 5 by Pierpaolo Caricato, Doriana Gianfreda, and Antonio Grieco analyzes a model-driven decision support system to solve a variant of the cutting stock problem on a company that produces high-tech fabrics.

Chapter 6 by Mats Danielson, Love Ekenberg, Mattias Göthe, and Aron Larsson introduces a procurement decision support system implementing algorithms targeted for decision evaluation with imprecise data that it can be used as an instrument for a more meaningful procurement process.

Chapter 7 by António J. Falcão, Rita A. Ribeiro, Javad Jassbi, Samantha Lavender, Enguerran Boissier, and Fabrice Brito presents a model-driven evaluation support system for open competitions within Earth observation topics.

Chapter 8 by Narain Gupta and Goutam Dutta presents the design, development, and implementation of a model-based decision support system for strategic planning in process industries.

Chapter 9 by Andreja Jonoski and Abdulkarim H. Seid explains the experiences in developing and applying a model-driven decision support system in a trans-boundary river basin context, taking the Nile Basin decision support system as a case.

Chapter 10 by Manfred J. Lexer and Harald Vacik presents a data-driven decision support system for forest management that can support all phases of the decision-making process.

Chapters 11 and 12 by Mário Simões-Marques examine in detail a decision support system for emergency management. Chapter 11 describes the problem context, the system requirements and architecture, the knowledge management process, and the spiral development approach, while Chap. 12 presents the main features implemented in the proposed decision support system.

Finally, Chap. 13 by Mette Sønderskov, Per Rydahl, Ole M. Bøjer, Jens Erik Jensen, and Per Kudsk presents a knowledge-driven decision support system for weed control that offers herbicide dose suggestions based on a large database of the existing knowledge of herbicides and herbicide efficacies.

We are very delighted to have included in this book a set of high-quality and interesting pieces of research, authored by researchers and industrial partners coming from different research institutions, universities, and companies across different continents. We are grateful to all reviewers and authors for the collaboration and work they have put into this book. We especially want to thank Daniel Power for writing the introductory chapter that introduces the main concepts that define a decision support system and prepares the readers for the remaining chapters of this book.

We hope that you will also enjoy reading the book, and we hope the presented “good” and “bad” practices on developing and using a decision support system can be useful for your research.

Thessaloniki, Greece
Pittsburgh, PA, USA
Namur, Belgium

Jason Papathanasiou
Nikolaos Ploskas
Isabelle Linden

References

1. Alter, S.: A work system view of DSS in its fourth decade. *Decis. Support Syst.* **38**(3), 319–327 (2004)
2. Arnott, D., Dodson, G.: Decision support systems failure. In: Burstein, F., Holsapple, C.W. (eds.) *Handbook on Decision Support Systems 1 Basic Themes*, pp. 763–790. Springer, Berlin, Heidelberg (2008)
3. Eom, S.B.: Reference disciplines of decision support systems. In: Burstein, F., Holsapple, C.W. (eds.) *Handbook on Decision Support Systems 1 Basic Themes*, pp. 141–159. Springer, Berlin, Heidelberg (2008)
4. Prakken, B.: The (economic) evaluation of investments in information systems and in ICT. In: Prakken, B. (ed.) *Information, Organization and Information Systems Design*, pp 197–222. Springer, Berlin (2000)

Contents

1	Computerized Decision Support Case Study Research: Concepts and Suggestions	1
	Daniel J. Power	
2	ArgMed: A Support System for Medical Decision Making Based on the Analysis of Clinical Discussions	15
	Malik Al Qassas, Daniela Fogli, Massimiliano Giacomini, and Giovanni Guida	
3	The Integration of Decision Analysis Techniques in High-Throughput Clinical Analyzers	43
	Anna Arigliano, Pierpaolo Caricato, Antonio Grieco, and Emanuela Guerriero	
4	Decision Support Systems for Energy Production Optimization and Network Design in District Heating Applications	71
	Andrea Bettinelli, Angelo Gordini, Alessandra Laghi, Tiziano Parriani, Matteo Pozzi, and Daniele Vigo	
5	Birth and Evolution of a Decision Support System in the Textile Manufacturing Field	89
	Pierpaolo Caricato, Doriana Gianfreda, and Antonio Grieco	
6	A Decision Analytical Perspective on Public Procurement Processes	125
	Mats Danielson, Love Ekenberg, Mattias Göthe, and Aron Larsson	
7	Evaluation Support System for Open Challenges on Earth Observation Topics	151
	Antônio J. Falcão, Rita A. Ribeiro, Javad Jassbi, Samantha Lavender, Enguerran Boissier, and Fabrice Brito	

8	An Optimization Based Decision Support System for Strategic Planning in Process Industries: The Case of a Pharmaceutical Company	175
	Narain Gupta and Goutam Dutta	
9	Decision Support in Water Resources Planning and Management: The Nile Basin Decision Support System	199
	Andreja Jonoski and Abdulkarim H. Seid	
10	The AFM-ToolBox to Support Adaptive Forest Management Under Climate Change	223
	Manfred J. Lexer and Harald Vacik	
11	SINGRAR—A Distributed Expert System for Emergency Management: Context and Design.....	243
	Mário Simões-Marques	
12	SINGRAR—A Distributed Expert System for Emergency Management: Implementation and Validation	275
	Mário Simões-Marques	
13	Crop Protection Online—Weeds: A Case Study for Agricultural Decision Support Systems	303
	Mette Sønderskov, Per Rydahl, Ole M. Bøjer, Jens Erik Jensen, and Per Kudsk	
	Index	321

Contributors

Malik Al Qassas University of Brescia, Brescia, Italy

Anna Arigliano DII – Università del Salento, Via Monteroni, Lecce, Italy

Andrea Bettinelli OPTIT Srl, Viale Amendola, Imola, Italy

Enguerran Boissier Terradue UK Ltd, Old Jewry, London, UK

Ole M. Bøjer IPM Consult Ltd, Hovedgaden, Stenlille, Denmark

Fabrice Brito Terradue UK Ltd, Old Jewry, London, UK

Pierpaolo Caricato DII – Università del Salento, Via Monteroni, Lecce, Italy

Mats Danielson Department of Computer and Systems Sciences, Stockholm University, Kista, Sweden

International Institute for Applied Systems Analysis, Laxenburg, Austria

Goutam Dutta Indian Institute of Management, Ahmedabad, India

Love Ekenberg International Institute for Applied Systems Analysis, Laxenburg, Austria

Department of Computer and Systems Sciences, Stockholm University, Kista, Sweden

António J. Falcão UNINOVA, Campus FCT/UNL, Monte da Caparica, Portugal

Daniela Fogli University of Brescia, Brescia, Italy

Massimiliano Giacomini University of Brescia, Brescia, Italy

Doriana Gianfreda DII – Università del Salento, Via Monteroni, Lecce, Italy

Angelo Gordini OPTIT Srl, Viale Amendola, Imola, Italy

Mattias Göthe Department of Computer and Systems Sciences, Stockholm University, Kista, Sweden

Antonio Grieco DII – Università del Salento, Via Monteroni, Lecce, Italy

Emanuela Guerriero DII – Università del Salento, Via Monteroni, Lecce, Italy

Giovanni Guida University of Brescia, Brescia, Italy

Narain Gupta Management Development Institute, Gurgaon, Haryana, India

Javad Jassbi UNINOVA, Campus FCT/UNL, Monte da Caparica, Portugal

Jens Erik Jensen SEGES P/S, Aarhus N, Denmark

Andreja Jonoski UNESCO-IHE Institute for Water Education, DA Delft, The Netherlands

Per Kudsk Department of Agroecology, Aarhus University, Forsøgsvej, Slagelse, Denmark

Alessandra Laghi OPTIT Srl, Viale Amendola, Imola, Italy

Department of Electrical, Electronic and Information Engineering “G. Marconi”,
Viale Risorgimento, Bologna, Italy

Aron Larsson Department of Computer and Systems Sciences, Stockholm University, Kista, Sweden

Department of Information and Communications Systems, Mid Sweden University,
Sundsvall, Sweden

Samantha Lavender Pixalytics Ltd, Derriford, Plymouth, Devon, UK

Manfred J. Lexer University of Natural Resources and Life Sciences, Vienna, Austria

Tiziano Parriani OPTIT Srl, Viale Amendola, Imola, Italy

Daniel J. Power University of Northern Iowa, Cedar Falls, IA, USA

Matteo Pozzi OPTIT Srl, Viale Amendola, Imola, Italy

Rita A. Ribeiro UNINOVA, Campus FCT/UNL, Monte da Caparica, Portugal

Per Rydahl IPM Consult Ltd, Hovedgaden, Stenlille, Denmark

Abdulkarim H. Seid NBI Secretariat, Entebbe, Uganda

Mário Simões-Marques Centro de Investigação Naval (CINAV) – Portuguese Navy, Alfeite, Almada, Portugal

Mette Sønderskov Department of Agroecology, Aarhus University, Forsøgsvej, Slagelse, Denmark

Harald Vacik University of Natural Resources and Life Sciences, Vienna, Austria

Daniele Vigo OPTIT Srl, Viale Amendola, Imola, Italy

Department of Electrical, Electronic and Information Engineering “G. Marconi”,
Viale Risorgimento, Bologna, Italy

List of Reviewers

Guy Camilleri, IRIT, France
Csaba Csáki, University College Cork, Ireland
Pavlos Delias, Technological Institute of Kavala, Greece
Themistoklis Glavelis, University of Macedonia, Greece
Isabelle Linden, University of Namur, Belgium
Jason Papathanasiou, University of Macedonia, Greece
Nikolaos Ploskas, Carnegie Mellon University, USA
Theodore Tarnanidis, University of Macedonia, Greece
Georgios Tsaples, University of Rome, Italy
Andy Wong, University of Strathclyde, UK

The editors of this book wish to acknowledge their gratitude for the prompt and highly constructive reviews received from the researchers above in the various phases of this book's reviewing process.

About the Editors

Jason Papathanasiou is an assistant professor at the Department of Business Administration, University of Macedonia, Greece. His PhD was in operational research and informatics and he has worked for a number of years at various institutes. He has organized and participated in many international scientific conferences and workshops. He has published more than 100 papers in international peer-referred journals, conferences, and edited volumes and has participated in various research projects in FP6, FP7, Interreg, and COST; he served also as a member of the TDP Panel of COST and currently serves at the coordination board of the EURO Working Group of Decision Support Systems. His research interests include decision support systems, operational research, and multicriteria decision-making.

Nikolaos Ploskas is a postdoctoral researcher at the Department of Chemical Engineering, Carnegie Mellon University, USA. His primary research interests are in operations research, decision support systems, mathematical programming, linear programming, and parallel programming. He has participated in several international and national research projects. He is author of more than 50 publications in high-impact journals, book chapters, and conferences. He has also served as reviewer in many scientific journals. He was awarded with an honorary award from HELORS (HELlenic Operations Research Society) for the best doctoral dissertation in Operations Research (2014).

Isabelle Linden is a professor of information management at the University of Namur in Belgium, Department of Business Administration. She obtained her PhD in computer sciences from the University of Namur. She also holds masters degrees in philosophy and in mathematics from the University of Liège, Belgium. She is member of the CoordiNam Laboratory and the FoCuS Research Group. Combining theoretical computer science and business administration, her main research domain regards information, knowledge, and artificial intelligence. She explores their integration within systems as EIS, DSS, and BI systems. Her works

can be found in several international edited books, journals, books chapters, and conferences. She serves as reviewer and program committee member in several international journals, conferences, and workshops.

Real-World Decision Support Systems

Case Studies

Papathanasiou, J.; Ploskas, N.; Linden, I. (Eds.)

2016, XX, 327 p. 117 illus., 82 illus. in color., Hardcover

ISBN: 978-3-319-43915-0