Introduction

DSS: directions for the next decade

The idea of organizing a special issue about the next decade of DSS was borrowed from Keen’s paper (1987) in which certain predictions were made. Now, almost 15 years later, we are witnessing an unparalleled digital revolution brought by the Internet, intranets, superb multimedia and powerful and relatively inexpensive computing and storage facilities. With the increased number of new business models and e-commerce applications, we were interested to find out how DSS has been changed and what the DSS might look like in the next decade. Of the many papers that were submitted to the special issue, we selected what we believe represent some of the most important trends in DSS research and implementation. However, before we present the essentials of the six selected papers, let us look at some of the most visible changes that are relevant to DSS.

One of the changes that already occurred is the name of this journal which was expanded to include electronic commerce. Journals do not change names too often. However, as explained by the editors, the new name reflects the changing business environment and the recognition that electronic commerce is a major revolution that impacts, among other things, managerial decision-making processes. Similar changes occurred in many other DSS-related concepts. For example, the term DSS itself is seen less and less frequently both in the trade journals and in the vendors’ Web sites. Instead, terms such as business intelligence and OLAP are very popular. As a matter of fact, these terms practically eliminated the term executive information systems (EIS) from most vendors’ Web pages and product lists.

There is an increased recognition that business intelligence, which integrates many of the EIS, DSS and expert systems concepts, is becoming a necessary component in the second generation of enterprise systems, such as ERP, as well as in extremely integrated enterprise systems that include CRM and e-commerce components. Furthermore, this concept becomes highly related to data mining, which are incorporated into e-commerce, collaborative commerce and other derivatives of the digital revolution [5]. Even futuristic topics such as mobile-commerce recognize the need to incorporate decision support in resolving issues such as investing in advertisement, which is based on customers’ location. An example of the changes in the practical world is the inclusion of Web-based products and services in practically any DSS and especially in EIS-related vendors of the 1990s.

The early definitions of decision support systems (DSS) focused on four novelties: (i) methods and instruments for dealing with unstructured or semi-structured problems, which formed an improvement on management science and operations research methodology; (ii) interactive computer-based systems, which were built for managers and were more advanced than descriptive systems theory or traditional decision models; (iii) user-oriented systems, which formed a better platform for decision-making than batch-oriented MIS applications; and (iv) the separation of data and models in computer applications, which promised to form the basis for more effective modeling.

The implications of these novelties promised to be three-fold: (i) decision-makers could, more effectively than before, deal with unstructured or semi-structured, difficult problems which up to that time required extensive experience and expert knowledge, as they had not been dealt within operations research or management science theory; (ii) decision-makers could make better and more reasoned decisions without using optimization tools and without mastering...
advanced modeling; (iii) decision-makers could start making systematic use of their knowledge and experience in interactive problem solving processes.

Yet, these promises did not fully come true for a number of reasons, as it is a truism in the field that the key problems never appear to be technology-related, but they are “people problems”: (i) people have cognitive constraints in adopting intelligent systems; (ii) people do not really understand the support they get and disregard it in favor of past experience and visions; (iii) people cannot really handle large amounts of information and knowledge; (iv) people are frustrated by theories they do not really understand; and (v) people believe they get more support by talking to other people (even if their knowledge is limited).

In the new decade, which just started, we are getting larger groups of senior executives who are comfortable with IT and who have hands-on experience with the use of computers. Thus, some of the former roadblocks of the 1980s and 1990s for the use of IT in executive decision-making are being removed as the realization has grown that IT is both useful and valuable to the organization.

Modern corporations and their strategic business units will continue to loose their hierarchical organization structures. The stated objective is to create business entities, which are leaner, more flexible and more responsive to a rapidly changing business environment. This has been implemented as reductions in staff and middle management personnel, and senior managers and executives get involved much more directly with problem solving, decision-making and planning than they used to be in the 1980s.

In addition, the boundaries of business entities continue to expand and blur. Markets are global in most advanced products and services (which most business entities would want to work with) and the competition for market share, customers, resources and skilled personnel continues to escalate. The increasing complexity of the context for planning and the carrying out of business operations underline the need for support systems driven by advance and modern IT. It is another truism that the data, information and knowledge that should be mastered by the fewer senior people, who man the responsible positions in the leaner organizations, will continue to grow and become more complex. As the dynamics of the global markets increase, the need for accurate, more diverse and immediate information will continue to grow. This supports the need for a continued effective use of modern IT in support of planning, problem solving, decision-making, operations and management.

The first target for some sort of intelligent new generation of DSS technology should be the overwhelming flow of data, information and knowledge produced for the executives from an increasing number of sources.

The expert systems technology is now being replaced by a diversity of intelligent systems, which are built to fulfill two key functions: (i) the screening, sifting and filtering of a growing overflow of data, information and knowledge (described above) and (ii) the support of an effective and productive use of information systems, which quite often are tailored to the needs and personality of the user. The intelligent systems, which can be implemented for these purposes, range from self-organizing maps to smart add-on modules to make the use of standard software more effective and productive for the users.

Software agents (also called intelligent agents) have been designed and implemented to take care of the screening, sifting and filtering of data, information and knowledge. These Java-built components can be designed and implemented to search for data sources with user-defined search profiles, to identify and access relevant data, to copy the data and to organize and store it in a data warehouse. Other agents of the same “family” can then be used to retrieve the data, insert it in reports and to distribute it over e-mail according to topic-specific distribution profiles.

These software agents can be designed to combine with smart add-on modules to provide users with relevant data in a way, which reduces the time spent on the routines to a fragment of the time otherwise needed to search for, copy and combine, report and distribute the data.

Modern support systems research is focused on the theory and applications of intelligent systems and soft computing in management. This includes (but is not limited to) processes of (i) problem solving, (ii) planning and (iii) decision-making. The context for this research ranges from (iv) strategic management, (v) business process reengineering, (vi) effective collaboration, (vii) improved user–computer interfaces.
and (viii) mobile and electronic commerce to (ix) production, (x) marketing and (xi) financial management. There is also some work done on developing and implementing (xii) smarter IS applications for operational management. The methodologies used may be analysis or systems-oriented, they may be actions research or case-based or they may be experimentally or empirically focused. In the DSS, field studies are favored, which combine good theoretical results with careful empirical verifications, or good empirical problem solving with innovative theory building. An emerging, common denominator for many studies seems to be the design and use of intelligent and/or soft computing systems.

Soft computing includes research on fuzzy logic, artificial neural nets, genetic algorithms and probabilistic modeling. The added feature to the intelligent systems is that in soft computing, the machine-learning systems are developed using fuzzy logic and the fuzzy set theory as a theoretical and methodological basis.

The above changes are also reflected in the number of papers published with the terms DSS or GDSS in their title. More than 50% of all the papers submitted to this special issue avoided these terms. The same trend is evidenced in academic conferences. Some people even claim that DSS matured to the point that it can be considered as part of the mainstream MIS field and that it is losing its identity. In other words, they believe that DSS may disappear as a stand-alone field during the next decade. We do not believe that this is the case. On the contrary, we believe that decision support systems, regardless of what name(s) they are going to appear under, will actually thrive in the next decade. The following are the reasons why we believe in this development, as they are reflected in the papers of this special issue.

- Most of the challenges of the DSS, as we knew it, are still valid. For example, complex and integrated decision-making is still done semi- or completely manually. Decision automation is spreading among front-line employees and in middle management, but not to the top-level complex decisions.
- The so-called second generation of ERP clearly recognized the need for supporting not only transaction processing, but also online analytical processing.
- The ever-increasing amount of information and the flow of millions of unsophisticated consumers to the Internet create a need for consumer support systems. The current search engines and intelligent agents that try to broker the products and vendors (e.g., see Ref. [2]) are extremely inaccurate. Customers need support systems that they can trust. Otherwise, e-commerce in the B2C area will not flourish.
- Distributed DSS over the Internet and intranets enables the dissemination of DSS applications at a reasonable cost. Furthermore, several DSS vendors offer ASP services in which companies can lease both DSS development tools and DSS ready-made applications. This capability allows users to enjoy the latest technologies with continuously up-to-date software versions. ASP services are especially attractive for the so-called “profitability analysis”, “budgeting”, “project management” and other ready-made DSS applications, some of which are available for specific industries (such as banking). Also, ERP applications available from ASPs usually include a business intelligent component.
- Many decision support applications can be improved with the aid of various multimedia and document management tools, which are also available on the Internet from ASPs. Alternatively, their price and ease of use make them attractive for DSS in-house builders.
- Intelligent agents appear in increasing number of DSS applications.

How are all these developments reflected in DSS research and what will be the research directions in the next decade? Besides the focus on the design and use of intelligent and/or soft computing systems, considerable attention is being given to Web-enabled systems. We will see more and more studies on a variety of topics such as people–Web interaction, virtual teams, intelligent agents and e-commerce decision support. Also, there will be more studies that will bring together a variety of disciplines that will jointly handle issues such as consumer preferences and behavior and trust in e-commerce. The GDSS area is already moving to virtual teams where many research issues can be addressed (e.g., see Ref. [4]). Many of the electronic commerce research issues compiled by the IS World [1] are strongly related to decision support, and so is the suggested list of research topics of Shaw [3]. The concept of supporting executives will be enriched by studies of wireless devices and intelligent personal assistants.
Last, but not the least, is the DSS education. With innovations in virtual classrooms, there will be many interesting research issues such as collaborative learning in virtual DSS classes where students from different universities and even different countries will collaborate in solving complex managerial problems as part of their learning experiences.

Several of the above issues are discussed in the papers of this special issue. The highlights of these papers are as follows.

The papers

- The first paper, written by Shim et al., begins by tracing the development of the DSS concept since its inception in the 1960s and early 1970s until today. The authors recognize the major change that occurred in DSS due to the introduction of data warehousing and data mining as major facilitators of DSS and due to today’s Web-based DSS. The authors conclude that Web-based systems can be built today with less cost and increased functionalities.

Special attention is given to collaborative support systems which started in a face-to-face decision room and are moving to geographically distributed virtual teams supported by the Internet, intranets and groupware. Another topic addressed by the authors is the relationship between optimization-based models, such as mathematical programming, and enterprise decision support. The authors believe in the increased role of integrating various types of optimizations into complex decision situations. The paper ends with an analysis of active or intelligent DSS. The paper presents in each of the phases of DSS development over time the major research issues. Also, in all the above areas, the authors recognize the new capabilities provided by the Web and the potential contribution to DSS.

- The second paper, written by Beynon et al., deals with a user–computer interaction for effective DSS implementation. The authors propose a qualitative, human (user)-centered approach that is using an observation-oriented approach to data modeling, which integrates manual and automated activities. This approach, which they call interactive situation models (ISM), cannot be only innovative but also revolutionary and it can facilitate better human–machine interaction and thus the acceptance of DSS. The principles of the ISM are the major topic of this paper. Using their approach, the authors report on a practical timetabling instrument that showed an unusual degree of openers for interaction.

- The third paper, written by Nemati et al., looks at the integration of decision support, knowledge management and artificial intelligence in a data-warehousing framework. The concept of data warehousing is expanded to include the knowledge accumulated in organizations or acquired externally. The proposed architecture is designed not only to store knowledge but also to facilitate its capture and transformation into knowledge elements that can later be retrieved and shared. The paper also deals with the process of knowledge creation via collaboration or group work as well as tacit to explicit knowledge conversion via the facilitation of intelligent systems. Of special interest are the interactive model analysis systems (IMAS), which provide employees insights into business environments represented by the knowledge conversion models. After analyzing all the systems’ components, the authors examine the goals and requirements of what we call the knowledge warehousing. Similar to a regular data warehousing that provides for analytical processing, the knowledge warehousing provides the decision-maker with an intelligent analytical platform. However, in contrast with the data platform, the knowledge platform provides for the socialization, articulation, integration and understanding of knowledge management. As part of this process, data mining can be conducted as well as knowledge presentation. The paper describes some of the tools, including commercial ones, which can facilitate the process. Of special interest is the use of natural language-generated arguments concerning the validity of the models, meta-models and new knowledge created in this process.

- The fourth paper, written by Bolloju et al., proposes a framework for integrating decision support and knowledge management to enhance the quality of support provided to decision-makers. It differs from the previous paper since it provides a framework that integrates the four types of knowledge conversions, identified by Nonaka, into various decision support and knowledge management activities. The authors introduce the concept of model marts and model warehouse to capture externalized knowledge using techniques such as knowledge discovery and data mining. Model marts and model warehouses act as repositories for operational and historical decision
models, similar to the data marts and data warehouses. These entities can help in building organizational memory, understanding current decision-making pattern and analyzing changes in those patterns over long periods of time. The authors argue that the system based on their proposed framework will help designers and builders of decision support systems by minimizing the time and effort required, and will increase the chances of acceptance by decision-makers because their subjectivity in decision-making is reflected in the decision models. The authors suggest that their framework lays a foundation for building enterprise-wide support environments for the next generation decision support systems. Finally, the authors have identified challenges in integrating knowledge management and decision support systems and possible directions for further research towards this objective.

The fifth paper, written by Tung and Quaddus, extends the study of group support systems to the global arena. Due to the e-commerce, globalization and the Internet, one expects to see more virtual teams whose members are in different countries, exhibiting different cultures. The paper begins with a comprehensive review of empirical research regarding culture and group support systems, outlining the dependent and independent variables, the technologies observed, the research method, the type of culture involved and the major findings. Obviously, with dozens of studies, there were dozens of findings. In general, there was a clear relationship between culture and group behavior and its IT support.

A comparison was done between Australia and Singapore by replicating an Australian experiment, which was dealing with four of Hofstede’s cultural dimensions. The experiment was conducted in a laboratory rather than in a distributed environment in order to get a better-controlled environment. The experiment revealed that culture plays an important role in determining the effectiveness of decision conferencing (DC). As other studies indicate, Hofstede’s cultural dimensions are still valid for most countries and, therefore, they can be used for explaining the variations between countries. People with different values, preferences and beliefs tend to view and use group support systems differently.

Based on their and others’ findings, the authors recommend some critical success factors, both to the GSS designers and to its facilitators. The recommendations are extended to the distributed environment as well. Finally, recommendations are provided to the GSS researchers on promising research topics.

The final paper, written by Wang et al., claims that it is sometimes hard to fit DSS applications into working practices or organization environments. Decision-making is becoming more pluralistic and less hierarchical, determined not so much by position in the corporate hierarchy but much by the argumentative and evidential value. Such decision-making can only be supported by those DSSs with negotiation support facilities. Intelligent negotiation agents can be used to model many decision-making negotiation tasks. Such negotiation agents are able to interact and negotiate with users and with each other. In addition, a newly emerging constraint agent technology provides a promising solution for such negotiation agents since they differ from ordinary constraint-based problem solving systems and ordinary agent systems.

The paper provides a general and domain-independent framework with which a wide range of DSS-negotiating agents can be modeled. The integration of declarative and imperative representations is achieved by distinguishing between declarative and imperative components.

The proposed agent-based model has the following features.

- Constraint-based modeling. Constraints are the representation for constraint agents and constraint satisfaction is the basic formalism for agent reasoning.
- Interactive and negotiating. User preferences over the solutions are not embodied wholly as requirements. They can be transferred to the system by means of evaluating and revising the imperfect solutions.
- Adaptive and cooperative. The system takes the evaluation and revision as feedback from users of agents to improve the solution in an evolutionary way. The system learns from the dynamic user behaviors and adjusts its own problem goals to adapt the revised user preferences.
- Heuristic. Constraints are used to represent agent goals. Heuristic opportunistic search is able to find a nearly optimal solution in a short time.

It is our hope as the guest editors that this special issue will initiate and encourage debate about promising research areas and the future development of decision support systems.
References


