In this paper we will present an important category of Decision Support Systems (DSS), spreadsheet-based DSS. After a short review of literature, we will specify the main characteristics that make Microsoft Excel 2007 an appropriate environment for DSS building. Then, we will analyze the instruments throughout we can enhance the spreadsheet capabilities. We will conclude presenting our view about the use of spreadsheets as DSS generators.

Key words: decision support system, spreadsheet, models

1. Literature review

According to Peter Keen and Charles Stabell, the concept of decision support evolved from “the theoretical studies of organizational decisionmaking done at the Carnegie Institute of Technology during the late 1950s and early '60s and the technical work on interactive computer systems, mainly carried out at the Massachusetts Institute of Technology in the 1960s” [Power, D. J., (2003)]. An earliest definition of decision support systems appeared in an article written by G. A. Gorry and M. S. Scott-Morton in 1971. They defined these systems as “interactive computer-based systems which help decision makers utilize data and models to solve unstructured problems.” [Mora, Forgionne, Gupta, (2003), p. 102]. Another definition is the one given by G. M. Marakas: a decision support system is a system under the control of one or more decision makers that assists in the activity of decision making by providing an organized set of tools intended to impose structure on portions of the decision making situations and to improve the ultimate effectiveness of the decision outcome.” [Marakas, (2003), p. 4].

In general, decision support systems applications are made up of three components: model management, data management and dialog management (user interface management). More and more DSS include also a knowledge management component which provides the necessary expertise and knowledge for resolving difficult and complex problems. We can classify DSS applications in many ways. One of the classifications is based on the dominant components of DSS application. D. J. Power identified five specialized types of DSS: data-driven DSS, model-driven DSS, knowledge-driven DSS, document-driven DSS and communications-driven DSS [Mora, Forgionne, Gupta, (2003), p. 24]. Holsapple and Whinston categorize DSS into six frameworks: text-oriented DSS, database-oriented DSS, spreadsheet-oriented DSS, solver-oriented DSS, rule-oriented DSS and compound DSS [Turban E., (2000), p. 113-114]. At the beginning, most of DSS applications were model oriented and were using accounting and financial models, optimization models, representational models, etc.

A paper spreadsheet is an accounting ledger page with columns and rows that organizes data about transactions and shows quantitative information useful for managing a business. Paper spreadsheets have been used in accounting for hundreds of years. A spreadsheet shows the expenses, revenue, taxes, etc. and the columns and rows represent either debit or credit sides. Professor Richard Mattessich had an important contribution in the development of computerized spreadsheets. Between 1960 and 1967 he wrote a number of papers and books on computer spreadsheets in which he developed the following subjects: the use of matrices or spread sheets, the simulation of financial events, financial spread sheets and the calculation that support each matrix cell. Later, in 1978, Daniel Bricklin, student at Harvard Business School, came up with the idea for an interactive visible calculator and, along with Bob Frankston invented and created the first spreadsheet software named VisiCalc. Electronic spreadsheets became popular only after the introduction of Personal Computers, in 1980s. In the early 80s, spreadsheets were also used for building model-driven DSS [Power, D. J., (2004)]. In an electronic spreadsheet information are organized into software defined...
columns and rows. The data in the worksheet can be summarized using diverse functions. The most popular spreadsheet programs are Microsoft Excel, Lotus and QuattroPro.

A DSS can be built in two ways: using a DSS generator or using primary tools. Sprague and Carlson defined a DSS Generator as “a package of related hardware and software which provides a set of capabilities to quickly and easily build a Specific DSS” and DSS Tools as “hardware and software elements which facilitate the development of a specific DSS or a DSS Generator” [Sprague, H. R., Watson, J. H., (1993), p. 9]. A generator is software that provides a number of instruments for building a DSS, it does not automatically generate the system. Spreadsheet packages can be used as DSS generators because: they offer instruments for building a variety of models (statistical, financial, optimization, simulation, representational), they offer graphic capabilities for data representation, can perform what-if analysis and can be used to develop quickly and easy a specific DSS.

Decision support systems that are built using spreadsheet software can be called spreadsheet-based DSS. [Power, D. J., (2004)]. Spreadsheets can be used to build data-driven, model-driven DSS and solver-based DSS. Spreadsheet are appropriate for building a DSS with small models, for building a DSS prototype or for testing the DSS models, etc. The user interface can be build using buttons, lists and the operations can be automated using Macros or Visual Basic. For data-driven DSS data can be imported from a DBMS, a web site or a text file. If one wants to use a DSS generator for creating a specific DSS can choose between the well-known software products: Microsoft Excel, Lotus 1-2-3 (IBM Lotus Development Corporation’s product) or Quattro Pro (Corel’s product). These programs are included in Office Suites: Microsoft Office, Lotus SmartSuite and Corel WordPerfect Office. In our paper we choose Microsoft Excel in order to examine the capabilities of spreadsheet and their importance in DSS development.

2. Building DSS using Microsoft Excel 2007

A great number of customers are using Microsoft Excel in order to realize calculations, analyses and reports necessary for decision making process. Due to the fact that it is the most used software for spreadsheet, the DSS creation in Excel facilitates the accessibility and the easiness of use for customer. As a result of the new facilities included in Microsoft Excel 2007, we consider it as being an appropriate environment for DSS building. Our reasons are:

- contain instruments that can be used for developing the main DSS components: data management, model management, dialog management and knowledge management;
- for data management component the input data can be imported from external sources and can be updated using Data Connections Library. It is easiest to import data from external sources if the data connections libraries are customized. Microsoft Office contains drivers that facilitate the data import from the following data sources: Microsoft SQL Server Analysis Services, Microsoft Access, dBASE, Microsoft FoxPro, Microsoft Office Excel, Oracle, Paradox, text files, OLAP databases. Also, it can be used ODBC drivers. In order to use the latest data, Microsoft Excel 2007 offers to the customers the possibility of data refresh from the external sources;
- using Microsoft Query component, the user has the opportunity to: connect to external source of data, create queries, import the selected data using queries and refresh the data in order to synchronize them with the data from the external sources. The Web query instrument can be used to import data from web sites, if the data are organized in a table;
- high performance: in Excel 2007, a worksheet contains 1.048.576 rows and 16.384 columns. This allows the import and the process of a great quantity of data and eases the calculation process. Using Excel we can solve linear programming exercises with tenth thousand variables and other kind of problems with a great number of variables;
- the new version has a friendly interface – using the Office Fluent interface - oriented to results - the new version is easiest to use due to the fact that the commands and the options are logically grouped;
- we can create the DSS interface using Visual Basic for Applications;
- has a diversified collection of charts that can be use for the data and results presentation. The charts are easy and rapidly to make;
• the cells and the tables can be simply formatted using the Cell styles and Table styles. The tables contains Autofilters, while the typing of formulas inside the table cells is easy to make using the conditional formatting option;
• allow the conditional formatting of cells data: this facility can be used to highlight some values, to give a graphical image to the numerical data from the spreadsheet. Using color gradients, data bars and illustrations we can discover and illustrate important trends or exceptions;
• for DSS building, Excel offer a great number of statistical, financial, math and other functions. Excel 2007 has an resizable formula toolbar and permit the formula autofill;
• permit PivotTable creation – one-dimensional or two-dimensional reports that present data in synthetically manner, easy to understand by the customer. Using pivot tables the spreadsheet data can be grouped and summarized. To create a pivot table the data must be organized in a list. The Excel lists have the following characteristics:
  o each column contains only one type of information;
  o the first row contains the columns label;
  o the list does not contain blank fields;
  o the list is bounded by blank row and columns;
• allow to group, sort and filter the data: in Excel, data can be grouped, summarized (using different criteria) and sorted by diverse fields. The functions Filter and AutoFilter display only the information that verifies the imposed conditions (the other are temporary hidden). Excel 2007 has new filter and sort options, like multiple selection in AutoFilter, filter or sorting by color or quick filters for some types of data;
• Microsoft SQL Server 2005 Analysis Services allow the business data query. With the cub function we can build a customized report from an OLAP database;
• due to Excel Services integration and to the new file format XML Microsoft Office Excel introduction, Excel 2007 facilitates the share of spreadsheets. Using Excel Services a Excel worksheet can be dynamically displayed in HTML format and can be seen by other users through a web browser. With the help of a web browser, Excel Services can be used to browse, sort, filter, bring in parameters and interact with the data contained in the spreadsheet. The possibility to save the worksheets in XML, PDF or XPS formats eases the share of data in Excel 2007. XML (Extensible Markup Language) represents a standard code, universally for data schemes definition. XML simplify the data exchange, recognition and interpretation between different applications;
• using Office SharePoint Server 2007 the reports and the charts can be shared with other persons from the enterprise;
• allow What-If analyses;
• facilitates the solve of some problems using Solver or Goal-seek;
• permits the realization of various scenarios.

Even if the final DSS will be realized with specialized software, Microsoft Excel 2007 can be used to build the DSS prototype. In Excel the models are easiest to test and analyzed.

3. Add-ins for Microsoft Excel
The spreadsheet capabilities (functions) can be extended using add-ins products. The integrated set of products offered by Palisade (Decision Tool Suite, Neural Tools, Palisade Developer Kits, @Risk, etc.), Frontline Systems’ Solver, Decision ToolPack (Decision Tree Add-in, Sensitivity Analysis Add-in, Monte Carlo Simulation Add-in) provided by Decision Toolworks or Crystal Ball offered by Decisioneering are examples of such add-ins tools. Next, we will present the main characteristics and functions of such products.
Frontline Systems
- Excel Solver, Premium Solver, Risk Solver

Decisioneering
- Crystal Ball (Standard, Professional, Premium Edition)

Palisade
- DecisionTools Suite (@RISK, PrecisionTree, TopRank, RISKOptimizer), Evolver

Decision Toolworks
- Decision ToolKit (TreePlan®, SensIt®, RiskSim™)

1. DecisionTools Suite include the following tools:
   - @RISK – is a risk analysis add-in for Excel that can be used to identify hidden opportunities and avoid pitfalls. This product uses Monte Carlo simulation and allows the replacement of uncertain values in a spreadsheet with @RISK distribution functions and simulate. Based on historical data the user can obtain a distribution of possible outcomes and the probabilities of those outcomes occurring. The obtained results can be presented using presentation-quality graphs and charts.
   - PrecisionTree – is a decision analysis add-in for Excel which is used to create decision trees and influence diagrams in spreadsheets. The main functions of decision tree are to facilitate the communication and to model the decision making process. The results are presented using statistical reports, sensitivity charts and risk profile graphs.
   - TopRank – determine the most critical factors in spreadsheets automatically. The use of What-If analysis narrows the user’s analytical focus in seconds. TopRank scans your entire spreadsheet and identifies which cells affect the bottom line the most, and then ranks them in easy-to-understand Tornado charts and statistical reports.
   - RISKOptimizer – this optimization add-in solve tough combinatorial problems in Excel. Use genetic algorithms to find the best possible combination of controllable factors to lead to a desired result. The user can run a Monte Carlo simulation on the scenario to see the effects of uncontrollable variables. This product is available in DecisionTools Suite Industrial.
   - Evolver - is an optimization add-in for Microsoft Excel. Evolver uses innovative genetic algorithm (GA) technology to quickly solve complex optimization problems in finance, distribution, scheduling, resource allocation, manufacturing, budgeting, engineering, and more. Evolver is available in three versions: Standard, Professional, and Industrial.

2. Frontline Systems developed the Solver in Excel for Microsoft and therefore all their products are upward compatible from the standard Excel Solver included in Microsoft Excel.
   - Frontline Systems’ Solver Products (Excel Solver, Premium Solver) improve the simulation capabilities of spreadsheet with solvers for a variety of optimization problems. With the solver offered by Frontline Systems the user can solve much larger problems, much faster than with the standard Solver, and also can solve entirely new types of problems.
   - Risk Solver is a powerful tool for risk analysis in Excel. It uses Monte Carlo simulation that is up to 100 times faster than simulation using Excel alone.

3. Decision ToolPack is produced by Decision Toolworks and contain the following analysis tools:
   - TreePlan is specialized in building a decision tree diagram in an Excel worksheet using dialog boxes. Decision trees are useful for analyzing sequential decision problems under uncertainty. TreePlan automatically includes formulas for summing cash flows to obtain outcome values and for calculating rollback values for determining optimal strategy.
• SensIt performs sensitivity analysis on Excel a worksheet what-if model. SensIt automates sensitivity analysis and creates simple plots, spider charts, and tornado charts. In a decision situation, sensitivity analysis helps you determine which of your input assumptions are critical so that you know where to focus your effort for gathering more information or reducing uncertainty.

• RiskSim provides random number generator functions as inputs for user’s Excel worksheet model, automates Monte Carlo simulation, and creates charts. RiskSim automates the simulation by trying thousands of what-ifs consistent with user’s assessment of the uncertainties and displays the results in both histogram and cumulative distribution charts.

4. Crystal Ball automate "what if" analysis with Monte Carlo simulation. Quickly assign ranges of values to user inputs and automatically calculate thousands of different outputs and their probabilities. Record the results for in-depth analysis or summarized reporting with Crystal Ball's many reports, charts and tools. There are three versions of this product: Standard, Professional și Premium version.

• **Crystal Ball Professional:** include all the elements from Standard version plus some advanced features - OptQuest®, for finding the optimal solutions, CB Predictor™ for creating precise predictive models, Developer Kit to customize own models and Extreme Speed to run simulations up to 100 times faster.

• **Crystal Ball Versiunea Premium:** include all the elements from Professional version plus Real Options Analysis Toolkit.

Crystal Ball has also a component available as an Application Programming Interface for the Microsoft .NET Framework. OCB provides a framework of classes that can be use to perform Monte Carlo simulations and optimizations.

There are also other tools that can be used in order to build a DSS. In our paper we mentioned only some of them. Due to the great number of DSS generators existing on the market it is practically impossible to know all the available products, to compare these products and to choose the most suitable for developing a certain DSS application.

**Conclusions**

The main purpose of DSS is to support managers in decision making process, to improve the quality of their decisions and to reduce the necessary time to make a decision. DSS improve managers’ activities and the way the problems are solved. DSS support all phases of the decision-making process.

Spreadsheet programs are the most popular modeling tools because its incorporate financial, statistical, mathematical and other functions. The spreadsheet programs have evolved into an important tool for analysis, planning and modeling. Choosing Excel as a DSS generator has a number of advantages: is accessible, is known by a great number of business users, is easy to use, can perform a lot of analysis – optimization, simulation, sensitivity analysis, what-if analysis. We think that the development of spreadsheet programs had a great influence on the development of DSS, especially of the model-based DSS. The great number of Add-ins existing on the market proves that the decision analysis tools are considered as being important in companies’ activities.

**References**