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THE SUPPORT GIVEN BY DATA ANALYSIS IN THE DECISION-MAKING PROCESS IN INTERDEPENDENT ECONOMIC SYSTEMS

Dănuţ-Octavian SIMION, PhD Associate Professor
Athenaeum University, Bucharest, Romania
danut_so@yahoo.com

Abstract: *The paper presents the support given by data analysis in the decision-making process in interdependent economic systems. There are situations when solving the problems that arise in the performance of a company's activity involves the operative processing of data and obtaining useful information in substantiating decisions. A well-founded decision requires internal and external information, expressive indicators that reflect the processes and phenomena of the company's economic and financial activity, determine the limitation of the uncertainty that characterizes the company's behavior in the context. Together with the information, in identifying and choosing the courses of action, an important role is played by the rigor and personal experience of the decision-maker, because in the last instance, decision-making is an attribute of management. Built to assist the decision-maker in making decisions, interconnected economic information systems ensure the acquisition, analysis and interpretation of a large volume of information, helping managers to make quick decisions, Decision-makers thus have the opportunity to analyze a large number of possible solutions, to build several analytical and intuitive models for evaluating the results. Within the decision-making problem, specialized computer systems start from daily information about the economic environment, ensure their selection, interpretation and compaction to prepare the decision. Instead of multiple calculations, which provide inopportune information, sorting, selection, classification and evaluation operations are carried out, intended to organize the information, reduce uncertainty, lead to recommendations and options for action. Economic decisions must take into account the external environment specific to business, but must be based on historical data previously entered by a commercial company, valuing the rules and knowledge accumulated over time.*

Keywords: *decision-making problems, specialized computer systems, data from external environment, historical data, economic decisions, analysis and interpretation, expressive indicators*

JEL Classification: *C23, C26, C38, C55, C81, C87*

1. Introduction

In the economic field, there are computer systems built to assist the decision-maker in making decisions, which ensure the acquisition, analysis and interpretation of a large volume of information, helping managers in making quick decisions. Decision-makers thus have the opportunity to analyze a large number of possible solutions, to build several analytical and intuitive models for evaluating the results. In the competitive economic field, information systems for decisions help the analyst to establish a diagnosis on the present and the future of the firm based on data extracted from a source of accounting information. Considered a computerized documentation system, based on knowledge in the financial-accounting field, it helps the decision-maker to solve problems related to the analysis of the existing patrimonial situation, the conditions of financial balance and profitability, to highlight weak points and strong points, to make forecasts.

The analysis is mainly based on the information provided by the balance sheet, the profit and loss account and appendices, supplemented with information on the commercial, technical and human potential, with information highlighting the company's position on the market and the intensity of the competition. In the interconnected economic field there are no unique decision criteria, the elements of the result being sensitive to a multitude of factors, to assumptions regarding prices, the market, or economic growth. For example, a cost-effective solution from the point of view of general liquidity may be less good from the point of view of the treasury.

The accounting information is correlated with the specifics of the activity, with the results of exploitation or with the objectives established depending on the context. Thus, the interpretation of financial flows is done in a different way in the phases of expansion, maturity or decline of the company (Helversen et al., 2018; Kim et al., 2008).

The results of the financial analysis are obtained most of the time on mathematical models. They are subordinated to some general objectives, they are useful in formulating general economic policy recommendations. I am looking either to improve the framework necessary for making decisions, or to carry out a preparatory study to make a decision.

Theoretically there are several models for the same situation. The decision-maker, specialist in financial analysis, remains the last mediator who, interactively and depending on the context, performs calculations within the offered models, changes the representation model if necessary. Success is essentially based on the ability of the decision-maker to foresee events and to anticipate the consequences of their production.

2. Models and techniques used in the decision-making process with economic data in the foreground

In the general framework of the company's IT system, IT systems for decisions are included in the category of management systems. It is based on information from transaction processing systems and assists the managerial process at different decision-making levels. They extend towards the implementation of the decision, the orders resulting from the decomposition of the decisions reaching the level of the management system.

Used in the management of the company, Interactive Decision Support Systems are present in various stages of the decision-making process; at the tactical or strategic level they emphasize the flexible elements, assisting ad hoc requests and analysis. Data-driven ones respond in real-time to planned or unplanned requirements. Model-based ones provide solutions for a specific decision or a set of related decisions.

Unlike them, managerial IT systems provide periodic standard or exceptional reports, depending on predefined criteria, to cover the informational requirements of a functional department (Borrero-Domínguez & Escobar-Rodríguez, 2023; VanDerHorn & Mahadevan, 2021).

Transactional systems are designed to streamline and automate the processing, record keeping and reporting of transactions. Record current information and maintain database of transaction information. The quantitative and even qualitative increase in the information obtained from the processing of daily transactions did not lead to significant changes in the quality of the decisions made. There are numerous options for data processing, information evaluation, and adaptation to changes.

While transactional systems emphasize the integrity and consistency of data, being managed as a whole, interactive decision support systems regroup data spread across several databases according to a defined purpose, manage data organized distinctly by analysis subjects.

Broken down by operational departments, the decisions are found in directives necessary for operational management and take into account the particularities of the functional departments. The simulation is done on models

of the field of application and facilitates the decision-maker's choice of measures imposed by reality, by the concrete conditions in which the activity is carried out (Pouyan, 2023; Zhang et al., 2023).

Presented and sometimes even used independently, management systems make up a unitary system at the company level. Integrating specific information and communicating at different managerial levels, based on the data recorded in the primary documents, they build decisions for the entire company.

The decision-making process and the adoption of the decision

The substantiation of the decision is related to the establishment of objectives and the allocation of the necessary resources. It is done through analysis and simulation, with the participation of several elements: 1. the decision-maker, represented by a person or a group of persons. End user of the decision-making process, adopts the right solution based on acquired knowledge and accumulated experience. The decision maker structures information needs and standardizes data analysis procedures, it streamlines the structuring of incremental problems, the individual exploitation of the set of decisional alternatives modifies, depending on the data and the context, the sequence of operations that is not known in advance, communicate results easily The only component with which the user works directly, the interface subsystem, must give the decision-maker the feeling of a direct manipulation of information, facilitating creativity and associative thinking, stimulating the ability to formulate different alternatives in poorly structured conditions. The visual interactive system allows him to develop individual strategies through the flexibility it provides, through the set of intuitive tools available for modeling and analysis (Kim et al., 2008; Pouyan, 2023).

The decision-maker builds his own information system, which will allow him to solve in real time the problem subject to the exceptional process. The inputs to the decision-making process are represented by data, decision variables, models, restrictions that limit possible solutions, similar decision-making situations. The input data in a decision-making process comes from internal and external sources, from several databases, managed in different programming environments. They must be filtered, tested and consolidated in order to fulfill the objective of generating suitable indicators and ah-hoc reports to assist the decision. In the case of building some models, the adoption of the decision is based on much more comprehensive information than that provided by reports and economic indicators. Mathematical or quantitative models are embedded in a model database, managed by a model management subsystem that separates users from the physical aspects of data processing and storage, extract, create, delete or modify models.

The decision-making process, carried out with the help of specific tools, methods and techniques, of scenarios built according to a defined purpose. Interactively, it replaces the classical, procedural execution with a decision-maker-directed execution according to the stages of solving a decision-making problem. Input coordination is done in most cases with software systems specialized in creating an analytical database, or with model building languages. In the first case, the user is provided with personalized views of the stored data by performing a diverse set of operations on the transactional data. The methodological approach starts from the data analysis to the extraction of information from the data and the obtaining of knowledge for the decision-making process. In the second case, for a specific problem highlighted in a model, one of the most used tools in the decision-making process, simulation, is used. Followed by optimization and forecasting, simulation assists the user in running complicated models, highlights the resulting variables whose value analysis leads to the adoption of a decision (Helversen et al., 2018; VanDerHorn & Mahadevan, 2021).

The outputs from the decision-making process are represented by analytical indicators that reflect the performance of the analyzed system, result variables, evaluation criteria or implementation plans. The evaluation of the results depends on the search method; the presentation of the results depends on the facilities offered by the dialogue component with the users. In addition to maintaining traditional information representation formats (graphs, maps, and diagrams) today, new types of dynamic graphics are used for multidimensional data representation. A simple dialog interface with the entire company is used, which allows connectivity and communication between networks with different topologies.

Types of decisions

In the economic field, depending on the time horizon, the level at which they are applied and the aspect under which the transformation of resources into results is viewed, decisions can be classified into:

- Strategic decisions, for long periods of time (4-5 years). It aims at objectives, resources and managerial policies. For their substantiation, along with internal information, external information is also taken into account, highlighting the company's connection with the external environment. They are related to the diversification of the activity, to new products, to the development of the position on the market.

- Tactical decisions, for periods between six months and two years. They are characteristic of the functional departments and are found in the forecast of the production plan, the acquisition and use of resources.

- Current (operational) decisions, for periods of up to several months. They look at obtaining the maximum profit from current exploitation and aim at fixing prices, promoting sales, allocating resources for research, development, and marketing.

Depending on the degree of structuring, decisions can be classified in:

- Structured (programmable) decisions, adopted in the case of problems for which there are solving algorithms. Being described by a fixed program, the decision-maker's contribution is determined more by his experience than by creativity and inventiveness. They are used in routine activities: commercial management, invoicing, calculation of indicators, accounting analyzes and those in the personnel-salary field.

- Unstructured (non-programmable) decisions for which there are no predetermined procedures, appealing to the decision-maker's intuition. It is adopted in exceptional or novel situations, based on models incorporated in a model base. The elements of the decision are more qualitative, the action option being chosen from information organized to reduce uncertainty.

- Semi-structured decisions, in which case it is possible to resort only partially to known procedures. The decision has predominantly quantitative elements, the objectives not being precise. This is the case of investment or financing decisions (Kim et al., 2008; Zhang et al., 2023).

The structuring depends on the complexity of the situation, on the restrictions inside the company or from the external environment, on the level of knowledge and experience of the decision-maker. The degree of structurability decreases as the decision-making level increases. Moreover, it can change over time, placing a decision in one class or another depending on the qualities of the decision-maker, on the accumulation of experience.

In the attempt to structure the decision, possible similar cases are checked, a solution space is built, the best forms of representation of the respective problem are found. According to some authors, decisions are structured when the formulation of the problem and the possible actions are found in a model. Herbert Simon even stated that "modeling is the structuring of unstructured problems". As an example, payment and collection are structured based on accounting models, supply and sale through operational research models. On the other hand, granting a loan for the client is a poorly structured decision, because there are no representations capable of evaluating the client's ability to pay, there is no analysis model that quantifies the creditworthiness, solvency and quality of the respective client.

The phases of the decision-making process

The complex process of knowing the real system, designing a decision-making model and choosing the best decision is divided into several phases. These phases take place sequentially, but leave the possibility of returning to the previous phases. Following an analysis of the results obtained and their reporting to the proposed objectives, differences are signaled and problems are identified that reveal the need to take action. In order to solve them, we try to fit them into a certain category, a fact that determines the approach to the problem through a standard method. Through additional information, the factors that determined the deviation from the expected result are selected and the importance they have in the context is appreciated. In complex cases, the problem is broken down into subproblems, easier to approach, easier to structure. The solution is the result of communication between all the decision-makers, who share responsibilities both at the level of the general manager and at the decision-making levels corresponding to the defined sub-problems (Helversen et al., 2018; VanDerHorn & Mahadevan, 2021).

The result of the information stage is a formal description of the identified problem, the category it belongs to and the responsibilities involved. For example, after the first phase, the decision-making sphere can concern the excessive expenses in a functional department, too high stocks or even the adoption of a research and evaluation project regarding the introduction of the computing technique. In the classification stage, it is established that the problems of excessive expenses or the problem of too high stocks are structured problems, because there are models for choosing a level of stock for a certain product (expenses) in the conditions of the existence of a constant demand, while the adoption of a project of research and evaluation regarding the introduction of the computing technique is an unstructured problem.

The establishment of responsibilities takes into account the fact that, in the reduction of expenses, the personnel policy under the given conditions is a problem for society, while the share of taxes in the budget is a problem for the government. The level of stocks is a problem of the management that contracts products, but also of the functional departments that study the market and the competition, or that ensure the rhythmic supply of raw materials and materials necessary for the production process.

Conception of the model

In this phase, a model for adopting the decision is defined, tested and validated under the conditions of the real system. Modeling succeeds in expressing reality with the help of abstract entities that possess quantitative and qualitative attributes. Based on the defined models, possible alternatives can be generated

through an effective simulation process. The decision-maker's intuition, creativity and experience allow comparing alternatives, predicting the results of each individual alternative.

Choosing the solution

It is the phase in which the results of the previous stages materialize, in which an action is chosen according to the selection criteria and the decision-making model. There is no strict demarcation between the conception of the model and the choice of the solution, certain activities can be carried out during both phases, or they can return from the choice phase to the conception phase. After the final solution of the model, the best alternative is selected, the implementation plan is chosen. The choice of the solution is closely related to the evaluation of the results corresponding to the respective solution. The rating in turn depends on the search method. In the case of structured problems (allocation of resources, stock management), analytical methods are applied, which use mathematical formulas to obtain an optimal solution. In order to increase the efficiency of the search for the best solution, algorithms are used. In the case when the number of alternatives is too large, when all or certain possible solutions are tested, incremental search methods (blind search) are used. Time and memory space limit searches, in most situations the decision maker stops at the best solution from those tested up to a certain moment. For complex problems, the solution is carried out by progressing from one situation to another, until a final situation, which represents the solution. The methods, called heuristic methods, are based on a rigorous analysis of the problem. Practically, successive attempts are made, the search progressing from one solution to another.

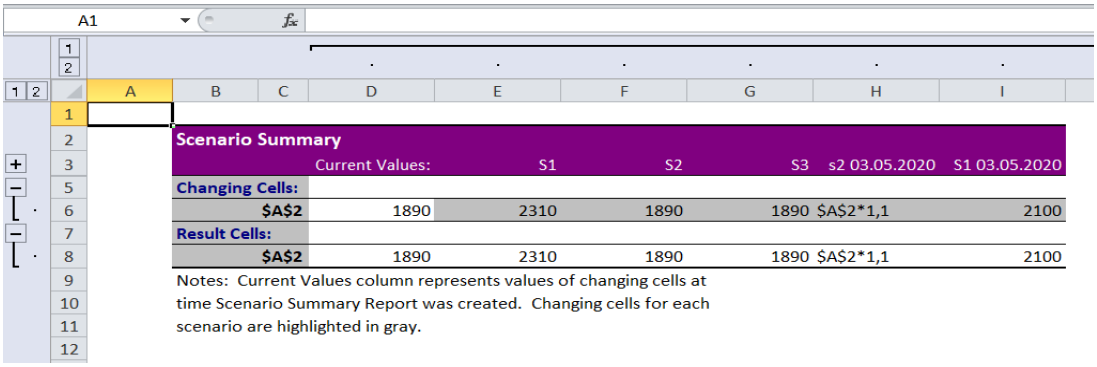
Implementation of the model

This is the last phase, the one that involves integrating the chosen solution into the context and simulating the conditions in the real system. Problems raised by the communication of the solution, the acceptance of the decision or additional costs, make the implementation a difficult process, in which the decision-maker plays the important role of the mediator (Borrero-Domínguez & Escobar-Rodríguez, 2023; Zhang et al., 2023).

3. Usage of data in application for Interactive Decision Support Systems

For example this problem requires the selling price of a product is 4,750 euros. The total fixed costs are 159,000 euros. It is estimated that the value of unitary

variable expenses is 2,100 euros. It is required to provide some information for the analysis of the influence of variable unit expenses in determining the profitability threshold expressed in physical units. Solution: The problem data is entered into an Excel spreadsheet. For variable unit expenses of 2,100 and for the corresponding changes (+/-10%), scenarios are built using the Scenarios option from the Tools menu of the spreadsheet. For the comparative analysis of the results, the user can display the three scenarios on the screen (Show option).



Scenario Summary						
	Current Values:	S1	S2	S3	s2 03.05.2020	S1 03.05.2020
Changing Cells:						
A2	1890	2310	1890	1890	A2*1,1	2100
Result Cells:						
A2	1890	2310	1890	1890	A2*1,1	2100

Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.

Fig. 1 – Scenarios application tool

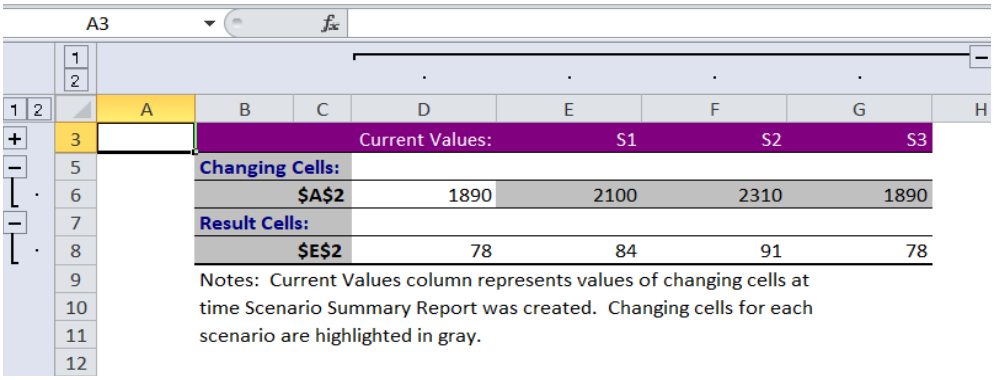
Another scenario usage is the following problem:
The total fixed costs and the selling price for a product are those in the following table. To determine the number of units sold to obtain a profit of 64080. To highlight the number of units sold to obtain a profit of 64080, in the case of variable expenses of 2100, as well as for variable unit expenses modified by +/- 10% .

Solution:
- the profit is obtained with the help of the formula:

profit =x(c-a)-b, where:
a = unit variable costs
b = total fixed costs
c = unit sales price
x = quantities sold in physical units

- replacing the data in the formula we get:

if a = 2100 x = 84
if a = 1890 x = 78
if a = 2310 x = 91

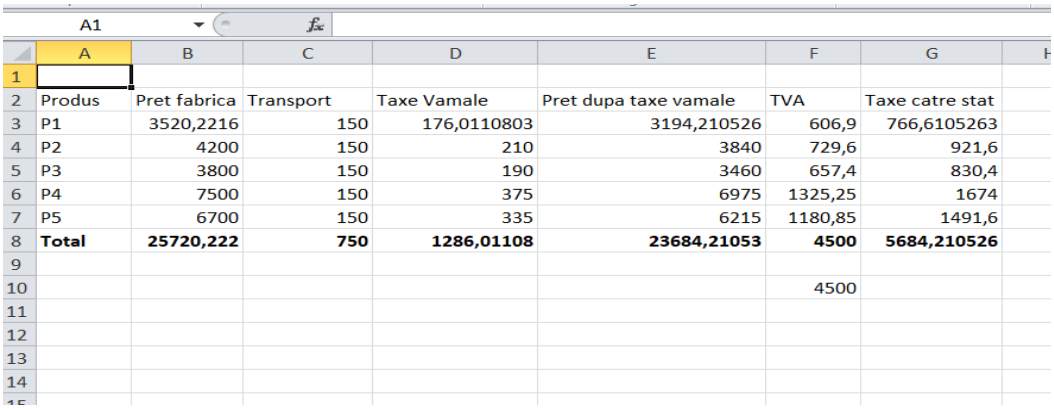


		Current Values:	S1	S2	S3
	Changing Cells:				
	A2	1890	2100	2310	1890
	Result Cells:				
	E2	78	84	91	78

Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.

Fig. 2 – Scenarios application tool solver

The following problem is a goal seek scenario:
A company supplies products from countries for which the tax regime is different. The management of the company is interested in establishing an optimal structure of supplies, so that the amount of taxes paid to the budget has a certain value. Solution: In the displayed spreadsheet, G8 is the cell that contains the formula for calculating total taxes. Using the Goal Seek tool in Excel, the user can modify the structure of the supplied products by imposing a certain value on the manufacturing prices, depending on the desired value of the total taxes.



	Produs	Pret fabrica	Transport	Taxe Vamale	Pret dupa taxe vamale	TVA	Taxe catre stat
3	P1	3520,2216	150	176,0110803	3194,210526	606,9	766,6105263
4	P2	4200	150	210	3840	729,6	921,6
5	P3	3800	150	190	3460	657,4	830,4
6	P4	7500	150	375	6975	1325,25	1674
7	P5	6700	150	335	6215	1180,85	1491,6
8	**Total**	**25720,222**	**750**	**1286,01108**	**23684,21053**	**4500**	**5684,210526**
10						4500	

Fig. 3 – Goal seek application tool solver

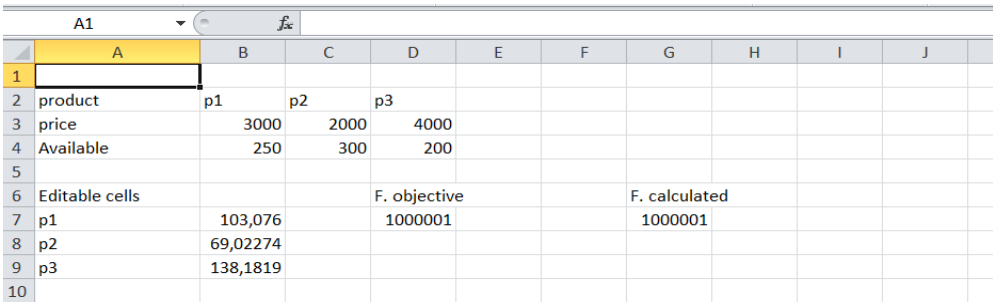
Another problem is the objective function that sets a value. A company decided to supply three products, with unit prices of 3.000 euros, 2.000 euros, and 4.000 euros, respectively. The maximum quantities that can be supplied are 250, 300 and 200 respectively. What quantity must be supplied so that the total value of the supply is 1.000.000 euros? Solution: To obtain the result, use

Solver, an Excel tool that allows solving optimization problems starting from a mathematical model Let P1, P2 and P3 respectively be the quantities for each of the three products. The mathematical model is:

1) objective function: [value of] 10000 f = 30*P1 + 20*P2 + 40*P3

2) the restrictions P1<250; P2 < 300; P3 < 200

Initial entry in the spreadsheet:



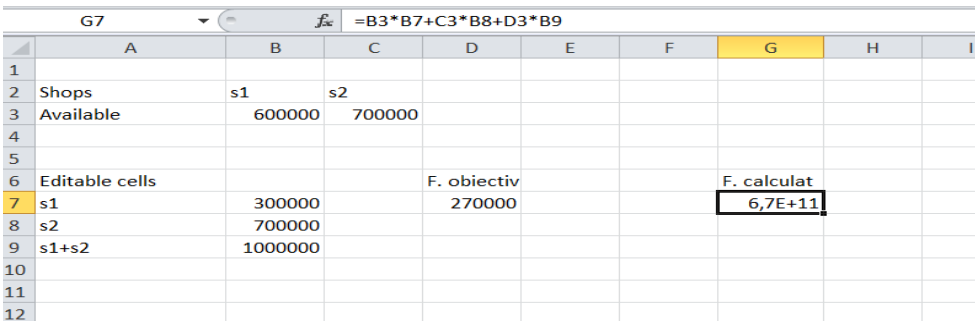
	A	B	C	D	E	F	G	H	I	J
1										
2	product	p1	p2	p3						
3	price	3000	2000	4000						
4	Available	250	300	200						
5										
6	Editable cells			F. objective			F. calculated			
7	p1	103,076		1000001			1000001			
8	p2	69,02274								
9	p3	138,1819								
10										

Fig. 4 – Objective function that sets value application tool solver

Another problem is the objective function that maximizes his value. A company decided to make an investment worth 1.000.000 euros in its two sections. In section S1 the investment must not exceed 600.000 euros, and in section S2 it must not exceed 700.000 lei. The benefit obtained for the S1 section is 20% and in the S2 section 30%. What amount should be invested in each section so that the benefit is maximum? Solution: The mathematical model:

1) Objective function: [max] f = 0.2*S1 + 0.3*S2

2) Restrictions: S1+S2 < 1000000 S1< = 600000 S2 <= 700000 S1 > 0 S2 > 0 The result obtained with the Solver tool in Excel is the one presented in the following figure:



	A	B	C	D	E	F	G	H	I
1									
2	Shops	s1	s2						
3	Available	600000	700000						
4									
5									
6	Editable cells			F. obiectiv			F. calculat		
7	s1	300000		270000			6,7E+11		
8	s2	700000							
9	s1+s2	1000000							
10									
11									
12									

Fig. 5 – Objective function that maximizes his value application tool solver

Decision support systems represent a natural evolution from information reporting systems to transaction processing systems. These systems are interactive, representing IT-based information systems that use decision-making models and specialized databases to assist managers in decision-making processes.

4. Conclusions

Decision support systems are different from transaction processing systems, which focus on processing data generated by transactions and business. Also, they differ from information reporting systems that focus on providing pre-specified reports for managers, reports that help them make complex decisions. Instead, decision support systems provide information to managers in an interactive session or in an ad hoc manner (depending on the need). Such a system provides analytical modeling, data retrieval, and information presentation capabilities that enable managers to generate the information needed to make decisions in an interactive computerized process (Borrero-Domínguez & Escobar-Rodríguez, 2023; Kim et al., 2023). When using a decision support system, managers research possible alternatives and receive experimental information based on a set of alternative assumptions. Thus, the decision-makers do not have to specify the information requirements a priori, the system interactively assisting them to find the information they need. Decision support systems are computer systems that help managers make important decisions considering different scenarios and data sources, but at the same time they can set goals and objectives, as well as the possibility to maximize or minimize certain indicators.

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