

## Risk-Assessment V1.0: A New Interactive Software to Develop Risk Assessment Using MATLAB®

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This article presents the use of an interactive computer tool developed in MATLAB® called RISK-ASSESSMENT v1.0, to perform market risk analysis of commercial products, through the development of cash flow, sensitivity analysis, and SpiderPlot graphics, which allow the identification of the economic-financial equilibrium point of a company. The tool facilitates the reduction of the uncertainty produced in the return on investment due to changes in the economic environment of the sector in which the company operates, through statistical techniques and tools that involve parameters such as the annual effective rate in the Colombian national currency, net present value, internal rate of return, period of recovery of capital, through a sensitivity analysis. To validate the effectiveness of using software in the development of risk analysis, a case study was conducted for an alcohol beverage sales business, where, based on the portfolio containing the product quantity, unit variable cost, sales price, percentage of sales growth and annual sales volume, in addition to detailed information on the initial investment, the cash flow with a 5-year horizon, the net present value, the internal rate of return, the period of capital recovery and the average accounting profitability are calculated. The tool also performs sensitivity analysis and SpiderPlot for each of the products. Finally, the program presented allows to calculate the annual cash flows in a fast and didactic way, which normally requires time and specialized training in a traditional exercise.

**Keywords:** Risk assessment, interactive software, MATLAB®, sensitivity analysis, cash flow, spider graphs.

### 1. Introduction

Risk is generally associated with uncertain events with undesirable consequences (Paquin et al., 2016), as an uncertain condition that, if it occurs, has a positive or negative effect on the objective of a project (Fontaine, 2016). In the economic context, investment is just one way to put extra money into an alternative or place to earn money (Urbina, 2007). The impossibility of predicting with certainty the amounts of income and expenditure of an investment project means that every decision implies the existence of a degree of risk, the magnitude of which will depend on the behaviour of the internal and external variables involved (Dugarte, 2015); for this reason, it is necessary to implement methods of analysis that allow us to act on a secure basis when allocating money to a new undertaking of any kind. However, the traditional methods used to evaluate investments fail to accurately assess the opportunities presented by an investment alternative in real assets and in scenarios of high uncertainty. One of the most commonly used traditional methods is the discounted cash flow method, which assumes a deterministic approach based on a single set of inputs, while assuming a fixed trajectory of project results, not considering the flexibility of changing the decision (García Ruiz, 2009). More modern techniques involving the implementation of specialized simulation software have recently been developed, which provides significant input into investment analysis under uncertain conditions and incorporates spreadsheets to support business decision making. However, these methods require highly trained personnel in the economic area, as well as regular technical support to stay operational, which

requires significant resources (Valencia et al. 2017). It is not the first time that software is used with mathematical programming that analyzes, simulates and shows the results of a specific model, its use in various thematic areas such as energy, mathematical model calculations, probability analysis, etc. (Koltsaklis, N.E., Dagoumas, A.S., Kopanos, G.M., Pistikopoulos, E.M., Georgiadis, 2013; A. Valera, A. Soriano, 2014; Barrozo F, Valencia G, 2017).

Therefore, this paper presents the development of a computer tool called RISK-ASSESSMENT v1.0, which reduces the uncertainty produced by the constant changes in the market, through the analysis of variables and indicators that help the user to make a decision under the minimum risk margin. The software was developed in MATLAB and is an interactive and user-friendly tool that gathers information about the project, providing clear graphs and balances that facilitate the understanding of the risk situations to which the investment project is exposed, and the possible alternatives that can be taken to reduce it.

## 2. Methodology

Below is a detailed description of the fundamental purpose of the software developed, plus a detailed description of the main views of the program, the fundamental equations used in the software and a flow chart of the calculation operations performed by the program.

### 2.1 General aim of the software

RISK-ASSESSMENT v1.0 software has an original, user-friendly and creative graphical interface that can be used and understood by undergraduate engineering students or young engineers with little experience, to have a significant learning experience through case studies for risk assessment in a business model. The software is based on educational components to give a deeper level of knowledge in business models, which gives an added value in the learning process of the users. In addition, as academic software, its use is open-free for any academic purpose, in particular, the free use has been an initial purpose in the development of this tool, as there is a significant percentage of engineering students in our region who cannot afford software with the capabilities mentioned above.

The software was developed with a level of complexity that allows it to be used by students who have not yet received their degree, allowing them to study in an easy and quick way the risks to which a commercial business model may be exposed, as well as facilitating an integral vision of the project, which helps to formulate an action plan for its success. Similarly, for young engineers with little experience in the real commercial market, software is a powerful and user-friendly tool that does not require in-depth knowledge of the financial area to identify possible commercial market movements that could negatively affect your business model.

Finally, the software allows to enter the business model information to carry out a pedagogical and orderly cash flow, the user is more involved in the variables that are implicit in the graphical interface of RISK-ASSESSMENT v1.0, which allows to show results by means of Spiderplots or graphs confronted in the form of results for sensitivity analysis. In order to show the pedagogical component of the software, two screenshots of the RISK-ASSESSMENT v1.0 software is shown in Figure 1, which shows the different options presented by the software, a menu to choose the option you want to work with at the moment. At any time, the user can study the desired variables and observe how they affect the input parameters through the graphs and results that the tool provides.

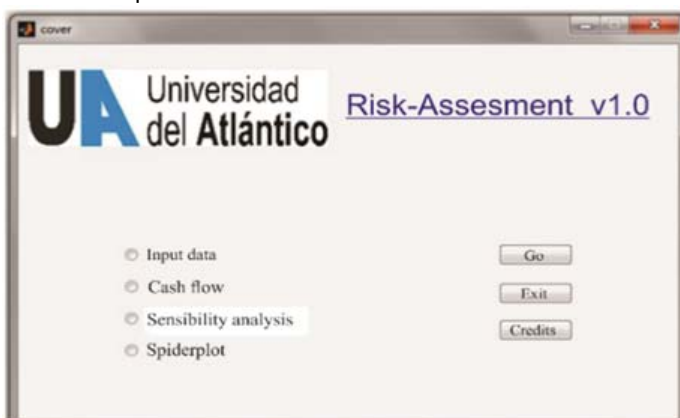


Figure 1: Main view software RISK-ASSESSMENT v1.0

**2.2 Fundamental equations**

The fundamental equations found in the software have been widely studied in the literature (ref), for the calculation of NPV we have

$$NPV = -P + \frac{FNE_1}{(1+i)^1} + \frac{FNE_2}{(1+i)^2} + \dots + \frac{FNE_n}{(1+i)^n} \tag{1}$$

where  $FNE_n$  is the net cash flow for year n, which corresponds to net income after tax in year n, P is the investment in year zero, and the reference rate that corresponds to TMAR. For the calculation of the investment in year zero, the following must be observed

$$P(1+i)^n = FNE_1(1+i)^{n-1} + FNE_2(1+i)^{n-2} + \dots + FNE_{n-1}(1+i) + FNE_n \tag{2}$$

Since the IRR is the interest rate that equals the future value of the investment to the sum of the equivalent future values of earnings, it is possible to compare the money at the end of the analysis period.

**2.3 Flow Chart of the Software**

RISK-ASSESSMENT v1.0 software was developed in MATLAB® 7.0. System requirements depend on the version of MATLAB® used. RISK-ASSESSMENT v1.0 runs on any version of Microsoft 32/64 bit. RISK-ASSESSMENT v1.0 software files use less than 428 MB of disk space. The computational steps are shown in Figure 2.

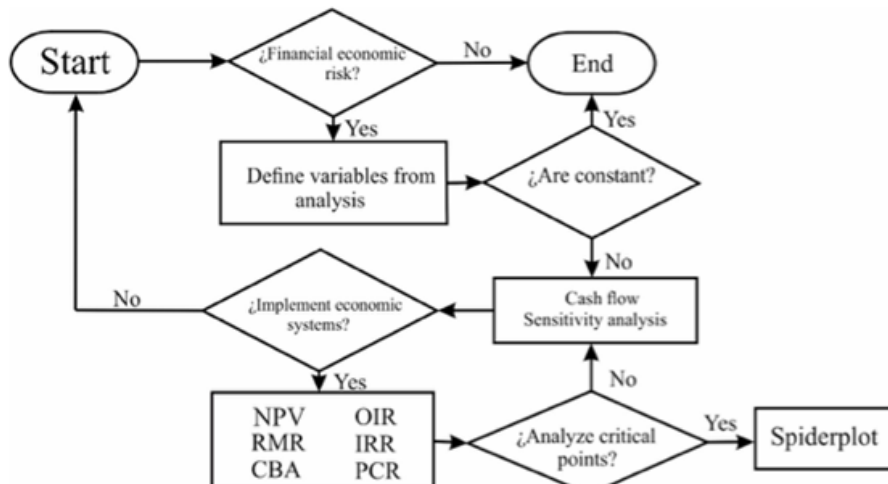


Figure 2: Flowchart of the RISK-ASSESSMENT v1.0 software.

**3. Results and discussions**

The above risk assessment was conducted based on a case study of a business model developed in a typical undergraduate economic engineering course, where RISK-ASSESSMENT v1.0 software was used to perform cash flow analysis, sensitivity analysis and SpiderPlot analysis of a business project. Determinants that directly affect the success of the project were studied, considering three determinants in risk assessment to introduce them as an essential part of the software.

**3.1 Cash Flow Analysis**

To train the neural network by retropropagation to estimate the second law of thermodynamics efficiency, from data operation such as the compressor efficiency, turbine efficiencies, and input air temperature, while keeping the fuel-air ratio fixed, 100,700 data were taken from the simulation in Aspen Hysys® and Matlab®. The results allow obtaining an average quadratic error of 0.0137 for 23 iterations for ten layers, 15 neurons per layer and 0.5 of learning constant. Figure 3 shows the behavior of the mean square error as a function of iterations for network training.

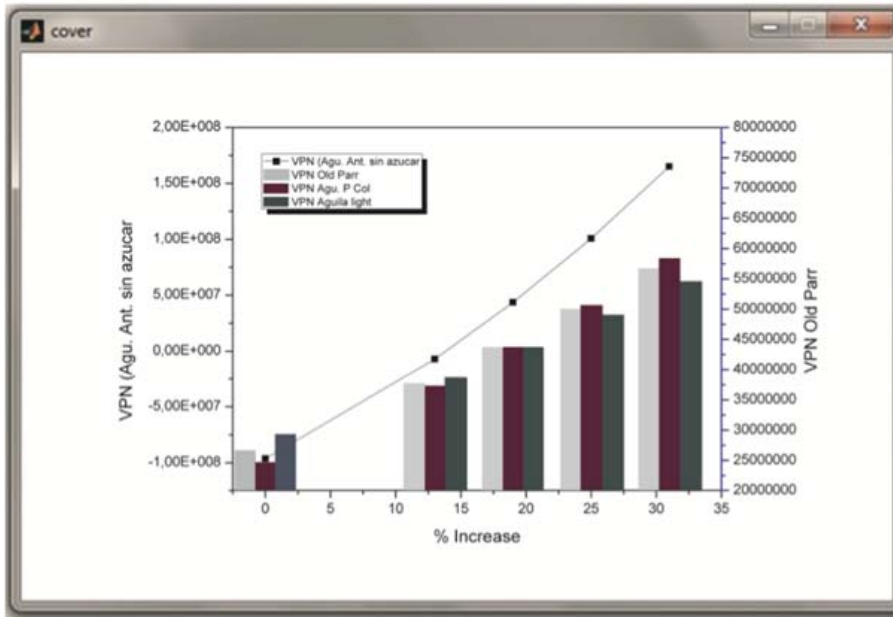


Figure 3: percentage increase with respect to the NPV of the products.

In relation to the income obtained annually from each product, a multiplier operation was performed between the sales price and sales volume values, which in literature is known as unit sales subtotals. On the other hand, unit variable costs reflect the sum of the value of sales volumes and the purchase price of each of the products. Finally, with the operations and restrictions explained in Figure 4, it is evident that the net cash flow for the company is not profitable until year three of operation of the business, due to the fact that the amounts are converted into debt cancellation expenses, related to the investment and only from year four, positive values are generated or in their absence recovery in the forecast for the following year (year five), with a Net Present Value of \$43,535,012.40 at an Internal Return Rate (IRR) of approximately 10.66%.

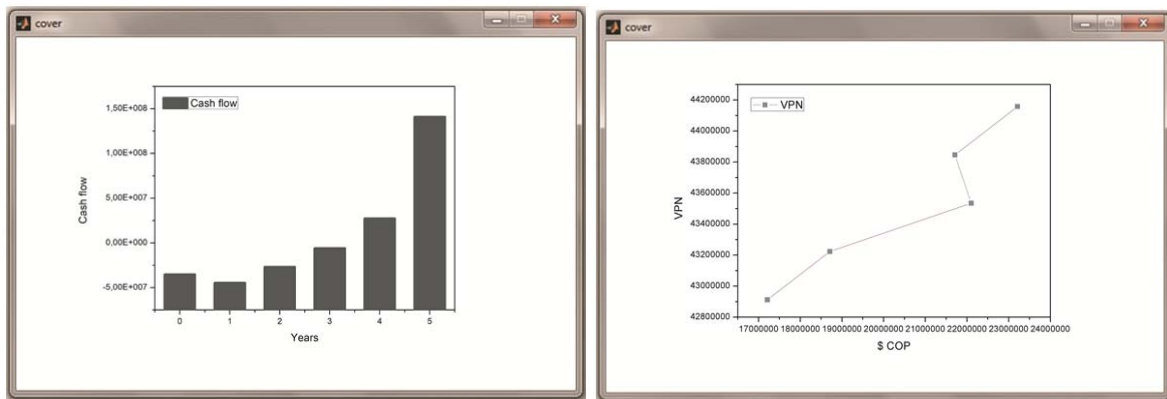


Figure 4: Cash flow and NPV for the five years studied.

### 3.2 Sensitivity analysis

The tool is used to perform a sensitivity analysis as shown in Figure 5, where the products with the highest sensitivity to changes in sales volume are: Aguardiente Ant. sin azucar and Whisky Old Par, which is 50% below the basic sales volume. In addition, all the products offered by the business have negative VPNs when the sales price is reduced by 50% and maintaining the sales volume for the product Aguardiente Ant. sin azucar or reducing it to 13% during the 5 years will not be profitable to cover all costs.

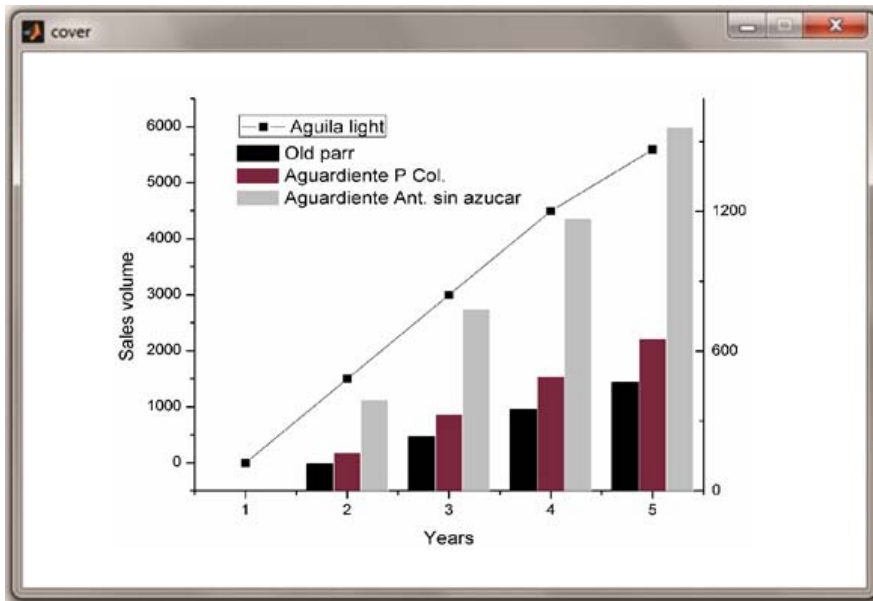


Figure 5: Sales volume with respect to the years studied.

The analysis showed that fixed costs, variable unit costs of products, investment in furniture and fixtures, intangible investment, the percentage of working capital and Good Will can vary without negative repercussions on the income or profitability of the business. In addition, it was possible to identify that the Minimum Acceptable Rate of Return is inversely proportional to the NPV, and that the project is feasible because the IRR is higher than the NPV and that by increasing the term of the loan will generate the company to obtain an increase equivalent to the NPV and that in turn by decreasing the loan rate will produce an increase in cash to the company equivalent to the NPV.

### 3.3 SpiderPlot

The graphical interface takes as inputs, values of, sales volume, % sales growth, unit variable costs and the total price of the product, allowing to make the multi-criteria network diagram, which is based on graphing from the VPN which corresponds to the value of \$ 43,535,012.20 of each of the products and with a base value of a percentage increase and decrease of 20% below and above the base value. In order to achieve this percentage, several iterations were carried out, until obtaining zero point, that is to say, no capital is lost, and no profitability is gained, which was called the base critical point. What an analysis of this type implies is to identify graphically the percentage range in which variables can oscillate, including the different types of investment, the cost of paying working capital, the loans, along with their payment terms and a constant RMR.

## 4. Conclusions

When there are market risks and opportunities for decision making to change the future course of the project, the analysis of real options can be provide a better evaluation. This analysis is not a substitute for methods based on the discounted cash flows, is a complement, and integrates to the traditional tools in a more sophisticated evaluation technique. Project evaluation determines the value of the option, adding a new component to investment decision making that does not consider traditional evaluation methods. Although there are several methods available for solving real-world option problems, the main difference lies in the degree of complexity in estimating input parameters, and how efficient they are at explaining the results. This software allows the financial evaluation of investment projects in fixed assets considering all the projections that support this evaluation, which also become elements of control and monitoring, positioning it as well as a tool of primary use in the evaluation of all types of projects.

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