A MULTI-CRITERIA DECISION-MAKING SYSTEM BASED ON A BUILD-UP ALGORITHM

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Abstract

The organization can be considered a real decision-making machine. Through the decision-making system problems are being addressed, searching for and proposing a solution and the steps to take which creates value for the organization and implicitly for its stakeholders. Whether it's about choosing the best resources, finding the best way to interact with customers, or taking the best position in front of a competitor, management has to decide. The current business environment imposes on organizations a high degree of rigor in developing strategies and a great complexity in substantiating managerial decisions in all areas of activity.

This paper presents a multi-criteria decision model based on a build-up algorithm. Thus, there are correlated methods that satisfy the necessity to include complexity and uncertainty in the decision-making process in order to achieve a high level of performance in the contemporary economic and social conditions.

Keywords: *algorithm, decision, risk, sustainability.*

1. Introduction

Planning and developing activities, designing the structure and culture of an organization, providing anticipated responses to occurring environmental events, choosing a technology to deliver products and services, defining a strategy to maximize the value of staff knowledge and skills to achieve performance, are elements which presuppose taking decisions.

Any activity carried out within the organization involves decisions, even though they differ in complexity and importance. The organization can be considered a real decision-making machine. At all levels and in any department, people make decisions at all times, and their degree of optimality significantly determines the level of value created by the organization.

Today, the decision-making process has a high degree of complexity due to innovative models and technologies, applicable to the new economic environment, to some resources with a high degree of novelty and the influence of some insignificant external factors so far. Decisions include social, ecological and economic concerns, and are much more complex and interrelated than in the past (Gong et al., 2016).

Organizations and their decision support systems must adopt procedures that are capable of interacting with this complexity (Courtney, 2001). Success must be planned and evaluated according to the principles of two great theories: complexity theory and chaos theory. Globalization and sustainable development are concepts that require new rules that underpin contemporary performance.

Under the globalization conditions and the dissolution of international barriers, there is a growing focus on global change.

Therefore, the global business community is characterized by a permanent change in the economic, political and social environment, the de-escalation of trade barriers, integrated economic markets, global consumers, diversified preferences, technological innovation, globalized production and cultural management, and today's change is faster and dominated by uncertainty.

This paper concentrates on the results of the in-depth research in the theory and practice of economic management and modelling, and presents the hybrid model developed on the basis of the interdependencies between the elements of sustainability, mathematical optimization and computer programming.

The suggested approach is based on a multi-criteria decision model. As such are correlated methods that satisfy the necessity to include complexity and uncertainty in the evaluation and selection of optimal decisions in order to achieve a high level of performance in the contemporary economic and social conditions. The model presented in the paper is specific to the investment decision, but it can be adapted to any other decision-making category in the business environment.

2. Background

Classical methods of substantiating decisions have a great inconvenience, which reduces the actuality of their use in terms of a development based on the sustainability of the surrounding world: they include exclusively monetary factors. However, the evolution of decision systems indicates the analysis of a decision

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for all categories of benefits, opportunities, costs and risks (Liang & Li, 2008), starting with the financial ones, but using additional and specific aspects of environmental protection or community development.

In terms of decision to invest, most companies use the expected economic value of the business as a basis for substantiating it. The classic indicators used to make such an assessment are: the recovery term, the economic return, the internal rate of return and the net present value. Two widely used methods, both in the internal evaluation of the projects of some organizations but especially as an integrated part of the evaluation process carried out for the financial allocation of the Community funds, are those aimed at determining the recovery period and the calculation of the updated cash flow cumulative or net present value (referred to in key industry papers also as value added / net present (Stancu, 2007), or net current income (Vasilescu, 2006)). This is often added to the analysis of the internal rate of return. Also, in addition to these (Vasilescu, 2006), it is considered necessary the inclusion in the evaluation also of some efficiency indicators, such as: the ratio between the updated revenues and the updated costs, the economic efficiency or the recalculated specific expenditures.

In determining the value of the updated cash flow, are considered elements such as the "time value" of money, the inflation rate, and the rate of return accepted by the investment organization (hurdle rate or cut off rate - the minimum rate required by the profitability of the company in the investment decision, the proposals not exceeding this threshold being rejected). Thus, in obtaining net present value (NPV), the annual cash flow (Inputs - Outputs) is updated and accumulated. Usually, in the first years of the analysis, the value of the flows is negative due to the investment effort, as the investment objective is functional at full capacity, the forecasts reflect positive values. A positive cumulative annual flux (NPV) indicates the acceptance of the evaluated project as the expected gain exceeds the rate imposed by the business standards involved. Given the need to choose a variation from many possible choices, the variant with the highest NPV should be chosen because it involves the lowest level of risk (the risk of not exceeding the required rate of return).

$$VAN = -I + \sum_{t=1}^{n} \frac{F_t}{(1+a)^t}$$

$$VAN = \sum_{t=1}^{d+D} \left[V_t - (I_t + C_t)\right] \cdot \frac{1}{(1+a)^t}$$

$$VAN = \sum_{t=1}^{d+D} V_t \cdot \frac{1}{(1+a)^t} - \sum_{t=1}^{d+D} (I_t + C_t) \cdot \frac{1}{(1+a)^t}$$

Where:

F_t = the expected net cash flow for the period t

n = number of periods

a - discount rate

t - the year in which you spend/receive income

V_t - annual revenue

I_t - the amount of the annual investment

C_t - annual production costs

d - the duration of the investment

D - running time

Including the potential effect of the inflation or deflation rate in the equation, converts the discount term $(1 + a)^t$ into $(1 + a + i_t)^t$, where i_t is the estimated inflation or deflation rate for the period t.

Two of the problems faced by evaluation, which require studies to define a performance methodology, aim to include indicators that consider respecting the dimensions of sustainable development, as well as choosing and substantiation of the discount rate in this context characterized by a new vision on the whole economy.

What is really important, but also very difficult, is to determine the rate imposed by the organization's standards in the selection of investment projects. Correct cash flow update requires an estimate of the appropriate discount rate. For many projects, the selected discount rate is the cost of the organization's capital, although it is often set too high, as a general risk tolerance.

The financial approach considers an investment a net gain if the promised internal rate of return proves to exceed the cost of the enterprise's capital (Schmidt, 2011). Each project must, however, be evaluated according to its own specificity and the imposed rate must take into account the risk class in which the rated project can be classified, not the whole business. For the case where the project is in competition with other alternative investments to obtain funding, the discount rate may be the opportunity cost of the capital (the rate of return to which the firm must give up if it invests in the project instead of investing in another alternative (ACCA , 2011)).

The causes of the risk and the possible changes that may influence the size of the discount rate should be carefully analysed, not randomly chosen. Any mistake in dimensioning it directly influences the investment decision. Therefore, the dimensioning of the factor used is one of the objectives of top-management. I believe that the existence of a concrete and complete model of calculation is a challenge in the field and a good opportunity to optimize the investment decision.

An increase in the discount rate implies a reduction in the predicted VAN, thus favouring the short-term selection of projects. The element that determines the recording of these results is the importance of the value of amounts according to the degree of removal of the period when they are obtained. In a long-term project, the costs recorded at the beginning are high in value, while revenues are delayed for several years, with lower and lower values. Implications may be far-reaching, for example (Mantel et al., 2011), the high interest rate levels of the 1970s, 1980s and 2000s in the US have imposed on organizations the focus on short-term projects and indifference to long-term investments as main sources of technological development, which has led to the

decline of US companies' competitiveness on the global market.

Moreover, the traditional approaches to substantiating the efficient allocation of capital in investment projects based on efficiency indicators imply implicitly throughout the life of the project the same business conditions as those underlying the investment decision.

However, market conditions change over time, and such changes could affect both future cash flows and estimated update rates, and thus the performance indicators of a project. A project that seems to be attractive today may not be so good at a later date when the business turns out to be no longer as favourable as predicted.

Therefore, in order to benefit from the investment opportunities offered by the national and especially international economic environment, in order to obtain the competitive advantage in a certain context, it is necessary to study the determinants of the respective context and the forecast of its evolution. The investment decision is strongly influenced by the specificity of the business environment in which the activity of the beneficiary organization is taking place and, implicitly, by the changes occurring or to occur at this level.

The macro-factors that influence the business environment and implicitly the investment decision are: legal system, economic conditions and cultural norms.

A country-specific business environment consists of all the factors that influence the benefits, costs and risks of running a business in that country. The size of the market, the purchasing power of the population or the expectations and needs of consumers are elements that need to be known in order to achieve organizational success. At present, they are characterized by ever more rapid and unpredictable changes.

An example in this regard is provided by Gomez-Mejia et al. (2005) on the situation of Argentina, which in the 1940s was among the states with the “healthiest” economy, and in the 21st century is not even among the top 40 countries, currently being characterized by political instability, poor economy and corruption. On the opposite side, we can discuss South Korea's evolution, which from a very poor third world country in the 1960s, it became one of the top 10 largest economies in the world and fourth in the world trade rankings after Japan, USA and Germany.

Managing a business implies also respecting the rules of the country in which you operate, these rules quickly becoming items with financial implications for the lead organization. Government taxes, holidays paid to employees, free days, double the Christmas salary, lack of infrastructure, or specific requirements for the quality of the products and raw materials used are different from one country to another and from one culture to another.

Carrying out an economic activity and, in particular, carrying out an investment, undoubtedly implies a certain level of risk. The risk differs significantly depending on the context in which reporting is made. However, in my opinion, in an environment characterized by complexity and uncertainty as the current one, risk is a positive element. Transforming uncertainty into risk is one of the greatest challenges, which decisively influences the performance of a decision. Risk cannot be avoided nor should such an approach be adopted; it is important to quantify it in order to substantiate decisions on a realistic basis.

In literature (Yean Yng Ling & To Phuong Hoang, 2010; Restrepo et al., 2012), risk is classified into three categories: political risk - specific to developing countries; indicates government changes, social disturbances, strikes, terrorism, or violent conflicts. This risk category is rated for each country by specialized agencies such as Bank of America World Information Services, Business Risk Management Intelligence BERI, Control Risks Information Services, Economist Intelligence Unit EIU, Euromoney, Institutional Investor, Standard and Poor's Rating Group, Moody's Investor Services (Ball et al., 2002); economic risk - captures elements that significantly influence the decision to invest, such as inflation rate, exchange rate or interest rate in a country; and legal risk.

The legal system of a country consists of rules defining what is allowed or illegal, the law enforcement process and procedures used to punish and redress offenses. The legal system of a nation reflects its culture, religion and traditions. A prime necessity in substantiating a business is law and compliance. The three major legal systems adopted by the countries of the world are: common law - in countries with historical or Anglo-Saxon influences, where the Court-based antecedents have an important role to play in interpreting the law (US and other 26 states); civil law - interpretations and sanctions are based on a complete set of rules that is part of a structured code (in about 70 countries, most in Europe and Japan); Muslim law - based on religious beliefs, regulates behaviour in about 27 Islamic countries (Gomez-Mejia et al., 2005).

The uncertainty of the economic environment is one of the factors that decisively influence the evolution of the business environment. The rate of inflation influences the evolution of an organization both by differentiation according to the host country and by the undergoing changes.

The exchange rate, another fluctuating macroeconomic indicator, also has implications for how to manage an investment. Considering an American company operating in Romania with a potential devaluation of the local currency (leu) in relation to the national currency of the country of origin of the organization (the dollar), it will receive less for the goods and services than was foreseen if the company perceives tariffs in the currency of the host country). In order to maintain the level of profit, the company must increase the price, which may lead to a reduction in future sales.

An example of this is provided by Darling & Nauss (1995) and addresses the effects of the exchange rate fluctuation on US companies in Mexico in 1995. The 40% reduction in the value of the Mexican currency against the dollar in January 1995 led to a decline in corporate income American presence on the Mexican market. Due to the price increases and demand reduction, industries such as cars, represented by companies such as Ford or General Motors, have experienced the influence of this indicator's variation. Another example may be tourism in France, whose profits dropped by 30% between 2002 and 2004, in which the value of the dollar diminished by 35% against the euro, which reduced the number of American tourists. Taxes are the third important economic factor that influence the activity of an organization. The variations in the tax policy are reflected in the value of each company's results. In Europe, income tax paid by companies varies from one country to another; so, in Bulgaria or Cyprus it is 10%, in Germany and France it reaches 30% (CWTFS, 2012). Another element that differs between countries is the licensing policy, which requires innovative firms to consider different copyright limitations and patent durations.

Culture is "collective programming of thinking that distinguishes members of one group from another, culture includes value systems, and values are the basis of culture" (Hofstede, 1984). Culture reflects specific characteristics of the social structure, religion, history of a region.

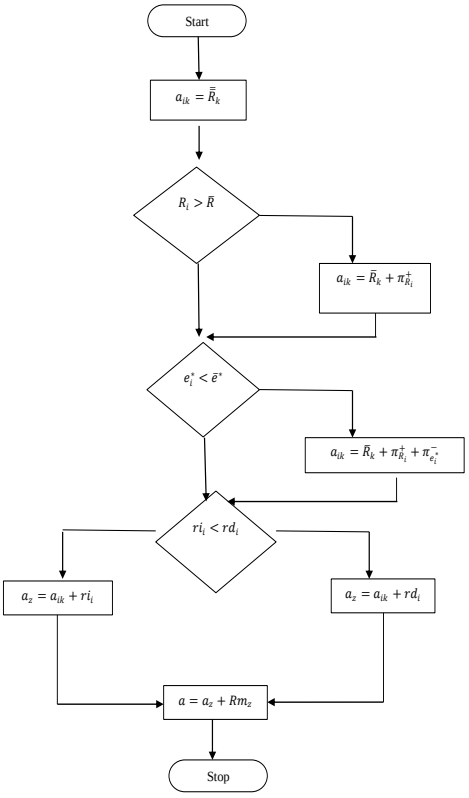
Internationalization requires organizations that attach great importance to performance, understanding and quick adaptation to cultural change. Cultural differences are grouped and categorized in five dimensions by Hofstede (2001): distance from power, individualism, avoidance of uncertainty, masculinity / femininity and long / short orientation.

3. The build-up algorithm

Decisions are significantly influenced by the forecasts on the evolution of the factors presented above, the design and the evaluation referring to the minimum level of profitability imposed by the conditions of the environment where the business is developed. In the context of sustainable development, efficiency and optimal decision-making acquire new dimensions characterized by increased complexity, which makes it even more difficult to quantify the level of a predicted risk based on which a correct justification and assessment can be made, indicating the decision generating the maximum performance level.

The key element for accurately planning and quantification the efficiency indicators is the rate or discount factor. Complying with the multi-dimensional reporting trends highlighted the need to quantify new investment risk factors. Thus, in order to determine the discount rate, a calculation model based on Build-up algorithms (Ibbotson, 2005) will be used further on.

Figure 1. The build-up algorithm



Source: author

The suggested model is described by the following formula:

$$a = \bar{R}_k + \pi^+_{R_i} + \pi^-_{e_i^*} + max(ri_i, rd_i) + Rm_z$$

Where:

a - discount rate;

R_k - the average risk rate of the industry/area of activity k recorded at the level of the European Union;

$\pi^+_{R_i}$- the country risk premium against the risk rate of the European Union;

$\pi^-_{e_i^*}$ - the risk premium against the sustainable efficiency e* of country i;

ri_i- country inflation rate i;

rd_i – interest rate in country i;

Rm_z - organization z size risk.

In order to draw a clearer picture of this model, the calculation algorithm is highlighted by the logic scheme shown in the figure 1.

4. Discussions

The risk is the alternative the individuals are most often confronting with, the idea that it represents a permanence of the human activity in general being unanimously accepted. Under these conditions it can be said that the activities with a high safety degree almost do not exist anymore, the risk notion becoming complementary with the activity one. Thus, we live in a risk's world, as Louis de Broglie (French physician, Nobel laureate in Physiks in 1929) was affirming, we

have to chase the risk because it represents the key of all succeses. In this context, the risk received a very big importance in all domains, its assuming becoming a common practice in the internal and international business environment.

Under these conditions, taking into account the path irreversible entered by the bond between the results of the economic activity and of the social and political environment, the analists but also the subjects directly implied in the international economic flows assign an increased importance to the concept of country risk. Under the conditions of the economic globalization, for the realization of some international investment flows under rentability conditions, there is imposed the identification and management of the risks that might appear in the receiving economied due to the particular political-economical and social conditions under which each national economy handles.

Any activity performed in the global economic environment is influenced by a basis risk, named riskless rate. If everybody runs with the same speed, we can say that we are all stand still. This safe risk rate id registered in USA under the titles of a mature capital market. The medium rate R_k has in its composition two risk categories: the general risk of the Euro zone and the medium risk of the k industry at the European Union's level. The general risk is determined as a risk premium to the global risk. According to the data bases built by teacher Damodaran (2013a), over time the risk premium of Euro in comparison with the basis rate is 0. It results thus that R_k has in its composition the risk rate of the titles in USA and the risk of the industry k in the UE. To this risk rate there will be added the country risk premium, namely the supplementary risk of the country to the risk of the Euro zone. Because the sustainable development plays an important role in the contemporary conditions, the model also has in its composition a risk rate of sustainable efficiency. Its determination is realized as a risk premium of the country's efficiency in the context of the sustainable development reported to the medium efficiency of EU-27 (Dinu, 2013).

For the complete definition of the rate there will be also taken into account a discounting rate of the inflationary phenomenon. Although reference papers in the domain add up the values of the inflation rate and of the interest rate, the proposed model takes into account the maximum of the two ones. The interest rate should have the minimal value equal with the inflation rate for the justification of the deposit's benefits and thus the economical theory would indicate the inclusion in the model of the interest rate. The motivation regarding the choice of the maximum is based on the results obtained through the evolution's study and the correlation of the two rates at Romania's level, which highlight the registering of some inflation rates superior to the interest rate in certain periods.

At organizational level, the discount factor determined according to the proposed model relates to the company's size risk (Joshi & Anand, 2018). Rm_z, also named size rating of the company z is being chosen by framing the indicator's value $interestcoverage = \frac{EBIT}{dobânzi}$ in the corresponding class (Damodaran, 2013b).

Thus determined, the discount rate value assigns the proper importance to the multiple risk classes implied in the decision-making system within the actual economy's context.

5. Conclusions

The distrust of investors in the implementation of sustainable principles but also the lack of such an evaluation model so far are the main limits of its application in practice.

The complexity, the risk and the uncertainty of the business environment are not, however, totally assessed and quantified using the suggested model, and probably will never be. The main contribution considered aims at adjusting the discount rate with a new class of risk, the efficiency of the development of investments in the context of sustainable development. The limits of the proposed model and also the main directions for further research on this particularly important detail in planning and obtaining a business' success, can refer to issues such as those presented in the conclusion of this article.

Defining country and industry risk is based solely on data provided by Professor Damodaran. The justification for choosing these databases is the recognition of their quality and correctness at the level of the world scientific community, through numerous articles published by the author, as well as references to them in important journals in the field.

If, given the existence of complete and up-to-date data on the evolution of some macroeconomic indicators, country risk could be quantified based on a multiple regression model or PANEL data, the industry's risk requires a complex and difficult task-based study that depends on the business environment, through their component organizations and their representatives, who often threat the research with indifference and find no time to engage in such a project.

That is why, an element that should be included in the suggested model for determining the discount rate is the industry risk premium for each country. Such an analysis may represent the goal of an entire research program, which will customize for each country the risk for carrying out activities in a particular field in the context of sustainable development.

The main contribution and originality element, the Sustainable Efficiency Premium, is determined for each country. The model does not quantify the efficiency of making a sustainable investment at the level of a field of activity and does not take into account aspects specific to the importance and necessity of including elements of sustainable development in the evaluation of projects belonging to different domains. A study for identifying, for each industry, of the risk quantification models is suggested for further research.

The inclusion of additional risk categories, the addition of other countries, choosing other time frames to analyse and the customization for other decision-making classes represent also limitations of the proposed model, which may be regarded as ideas for future research.

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