A MODEL OF STRATEGIC DECISION-MAKING IN THE GREEN INVESTMENTS PROJECTS

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Abstract: In order to make a strategic decision in green investments the top management is facing the process of choosing a project among a series of projects as strategic options or at least selecting between a proposed project and the existing strategy as it is. The investment process usually imply, when considering public projects or projects of a high amount of financing, the preparing of an opportunity study, a feasibility study, a business plan and the cost-benefit analysis, steps that are reduced at a summary when the projects are private or of a small amount of financing. But, nevertheless many projects are abandoned, caused by the management's lack of time to analyze deeply the projects, or due to the possibility of unconsidered risks to arise or the lack of a simple technique to support the management in a global evaluation of the possible or proposed options.
In this respect, the paper is offering a model of strategic decision-making in the green investments based on the projects' eco-efficiency. The multi-criteria analysis is used as technique in the models design. The analysis is using seven criteria, i.e. the investments cost, the sources of financing, the technical/operational parameters, the environment indicators, the financial-economic indicators, the risks and uncertainty and the investment's advantages.

*Keywords**:** management, strategic decision, green investments, eco-efficiency, model*

INTRODUCTION

One of the most important global strategic objective today and the next century is to reduce the gas emissions with the greenhouse effect. In order to reach out this target, the companies have to change into sustainable-green industry organizations. Nevertheless the main driver is the investments and the managers and their teams need to follow clear procedures in decision-making. The literature offers different models that may help the decision-makers to support their investments decisions. Most of the models are focused on specific directions of greening the economy, such as:

- GICO model (Sim & Jung, 2013) is a mathematical model to determine the optimal green investment cost in a supply chain environment in which a company's allowable greenhouse gas emissions are expected to decrease because of increasingly stringent restrictions on carbon dioxide emissions. This model can be used as a decision-making tool and as a negotiation tool between government and industries and it can assist

companies in assessing the feasibility of green investment and can assist policymakers in assessing the effectiveness of greenhouse gas regulations.

- The model of a representative wind power investor's decision making process using a Monte Carlo simulation of a project financial analysis (Gillenwater, 2013).
- The intelligent decision-making system for the smart grid based electricity market which requires distributed decision making on the competitive environments composed of many players and components (Kang et al., 2009).
- A procedure for deriving and including the uncertainty associated with various factors in energy retrofit option assessment. The analysis shows that considering the inaccuracy of a base model in the modelling process could improve the level of confidence associated with simulation outcomes and enhance the quality of investment decisions regarding green retrofits. It could alter an investment decision from 'no go' to 'go' (Bozorgi & Jones, 2013).

The use of models in investments decision-making in practice depends on the ‚ease of use', that is a consequence of „how the outcomes are clearly modelled" (Gray et al., 2013). The decision-making models are commonly based on techniques that may be easily handled, such as spreadsheet framework, which may conduct the empirical tests of stochastic dominance when comparing alternative capital investment plans under uncertainty (Donkor, 2014). The Decision Matrix Analysis is another useful technique to be use for making a decision, being really powerful when working with a number of options and many factors involved (Mindtools, 2014).

It is no doubt that these models and techniques have to be used „with some regularity and not just when the ultimate decision maker feels unusually uncertain about which call to make" (Lovallo & Sibony, 2010).

1. THE STUDY AIM AND METHODOLOGY

In order to take the strategic decision of the green investment, the top management of organizations faces a multitude of problems, from the lack of time to the process of choosing a project from a series of projects as strategic alternatives or at least the choice of selecting between a proposed project and the existing situation (the strategy „as it is").

In the public projects or the projects of high values, usually the investment process follows the next steps: opportunity study, pre-feasibility and feasibility study (including the business

plan and the cost-benefit analysis, in addition to the technical project), but in the private projects and small projects the number of steps is reduced, usually to a brief feasibility study. However, many projects are abandoned due to several causes, including: impossibility of global assessment of proposed variants; lack of project complete funding; suspicion of occurrence of risks not taken into consideration; lack of top management time for a thorough research of the problem; loss of aroused opportunity. In order to facilitate a quick decision, based on alternative projects prepared by the team of specialists or consultants working for the organization, a decision model is further proposed, simple and clear, responding to the global assessment need of existing or possible options and taking the decision. The proposed model, as a managerial tool for decision in the green investment strategies, is called *the model of **D**ecision-making based on **E**co-efficiency in the **G**reen **I**nvestments **S**trategy* (acronym DEGIS). The multi-criteria analysis has been used in developing the model (Negulescu & Lupulescu, 2013), namely, the analysis of multiple attributes (Hincu & Florescu, 2006, p. 126-128).

2. THE MODEL OF DECISION-MAKING IN GREEN INVESTMENTS

The modelling process, comprising seven stages, was used in designing the model, illustrated in the Figure 1.

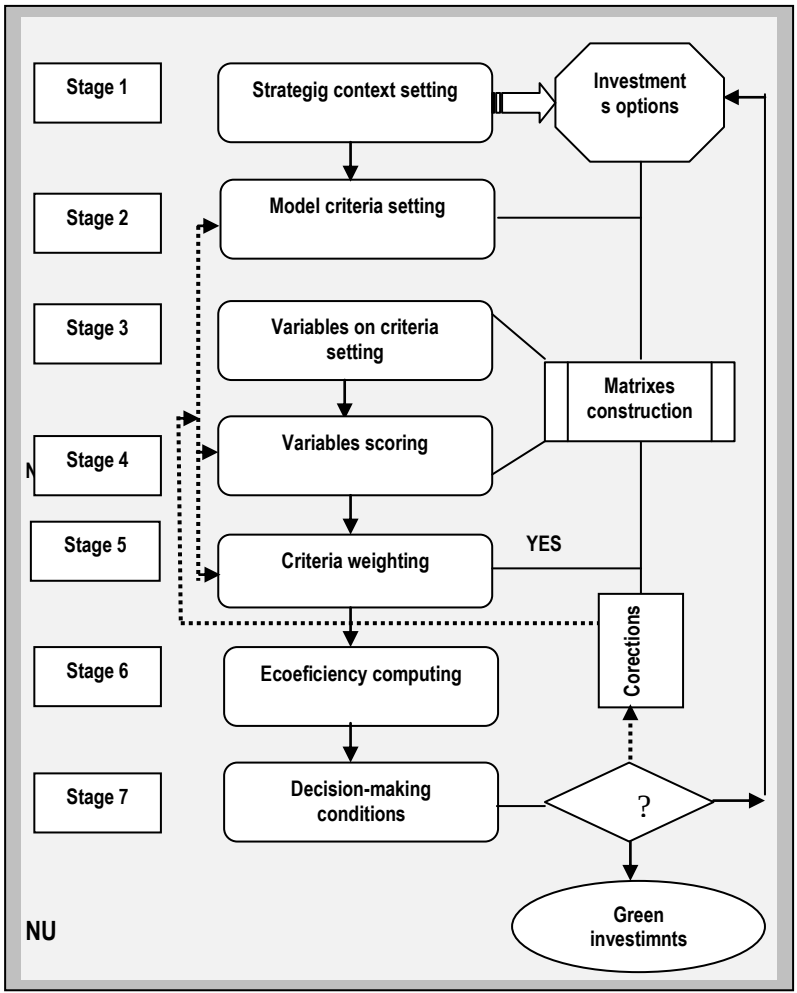

Figure 1 The stages of the modelling process

The seventh stages are:

- Establishing strategic context;
- Establishing model criteria;
- Establishing variables by criteria;
- Giving a score to variables;
- Weighting of criteria;
- Determining the eco-efficiency value;
- Determining the decision-making and selecting the green investment option.

Stage 1: Determining the strategic context of the green investment projects

Any investment strategy is designed or chosen based on strategic goals, related to the business strategy and especially to the green ones. The investment strategy will be translated into investment options. Nevertheless, the green investment option is given by the investment object based on strategic content, consisting of: strategic goal, which can be one or combinations of goals in line with the overall strategy of the company at the time of decision or for the future, and the green investment strategy.

The investment options O_i ; $i \in (1 \div n)$, where, O_i = investment option i, are defined.

Stage 2 The model criteria setting

The analysis of green investment options is performed based on the pertinence tree model and the following seven analysis criteria result:

- Investment cost;
- Sources of investment financing;
- Technical parameters (operating);
- Environmental indicators;
- Economic and financial indicators;
- Risks and investment uncertainty;
- Benefits of green investments.

The function is build for each option:

$D_{gi} = f(C, F, T, M, E, R, A)$ (1)

Where:

D_{gi} = green investment decision

C = green investments cost

F = sources of investment financing

T = technical parameters of operation

M = environmental indicators

E = economic and financial efficiency indicators

R = risk indicators

A = benefit of green investment

Stage 3: The model variables setting by criteria

The lists regarding possible variables on every criterion are drawn up.

An example of the listing is shown in the Table 1.

Table 1 Listing of the variables by criteria

No.	Criterion	Variables	Definition domain
1	Investment cost	depending on the provider (quantitative variable)	$c_1, c_2, ..., c_\gamma$ $\gamma \in (1 \div d)$
2	Sources of investment financing	- Own sources - Bank loans - Grant - Credit from suppliers - Leasing - Equity - Other sources - Combinations among funding sources	$f_1, f_2, ..., f_\varphi$ $\varphi \in (1 \div g)$
3	Technical parameters	- Capacity - Work speed - Productivity - Number of interruptions - Location - Material consumption - Other technical parameters - Combinations among technical parameters	$t_1, t_2, ..., t_\eta$ $\eta \in (1 \div h)$
4	Environmental indicators	- Level of emissions by activity (CO, CO_2, NO, NO_2, SO_2, powders, waste water, toxic products etc.) - Level of noise - Level of odour - Level of waste	$m_1, m_2, ..., m_\mu$ $\mu \in (1 \div v)$

		- Conventional energy - Gas consumption - Water consumption - Other indicators	
5	Indicators of financial and economic efficiency of the investment	- Financial net present value - Financial internal rate of return - Rate of return on capital - Financial sustainability - Payback time of investment - Net present economic value - Economic internal rate of return - The benefit/social cost ratio - Other indicators	$e_1, e_2, ..., e_\lambda$ $\lambda \epsilon (1 \div x)$
6	Risks and uncertainty	**-Legal** Tax changes Changes in environmental legislation Force majeure **-Economic and financial** Unavailability of financing Supplementation funding Inflation Exchange rate fluctuation Interest rate fluctuation Changes in labour market **-Commercial** Competition increase Demand decrease **-Operating** Input scarce resources Technical depreciation of equipment Maintenance of equipment Flexi-security of workforce Management capability **-Environmental** Systematic pollution Accidental pollution **-Social** Negative implications on human health Unemployment increase Negative implications on the community	$r_1, r_2, ..., r_\tau$ $\tau \epsilon (1 \div w)$
7	Advantages of green investment	**-Economic advantages** Cost decrease Profit increase Turnover increase **-Commercial advantages** Winning new markets Market stability Business ethics **-Social advantages** Creation of new jobs Health and safety of employees **-Advantages for the community** Social responsibility increases	$a_1, a_2..., a_\delta$ $\delta \epsilon (1 \div y)$

		The degree of civilization of the inhabitants - Other advantages - Combinations among advantages	

The variables that correspond to investment options are selected from the list.

Stage 4: Giving a score to the variables

The evaluation of the alternatives is achieved by applying the multi-criteria analysis with multiple attributes (Hincu and Florescu, 2006; Manual, 2009). A score is given to each criterion variable and the arithmetic average of the variable scores gives the value to the criterion.

The score for each criterion is defined: s_j, $j \in (0 \div 5)$. The scoring scale values in Table 2 are proposed for scoring.

The analysis is performed in a matrix form. Seven matrices are constructed for each criterion for each option: cost matrix (on suppliers), funding sources matrix, technical parameters matrix, environmental indicators matrix, economic financial indicators matrix, investment risks and uncertainty matrix and investment advantages matrix.

Table 2. The scoring scale values

Importance score sj	Significance
0	inexistent/strong negative impact
1	irrelevant/negative impact
2	moderate impact
3	relevant impact
4	huge impact
5	exceptional impact

In order to determine the financial efficiency of the investment, internal factors are taken into account and financial ratios are calculated. The external factors are considered in order to determine the impact of the investment on the social environment, so the economic indicators of the investment are calculated using shadow prices (if appropriate). The calculations specific to the cost-benefit analysis for investment projects are used (Florio & Maffi, 2008). The data are taken from the studies made by the enterprise experts or consultants.

Stage 5 Weighting the criteria

A weight is associated to each criterion (p_k), as an expression of its importance in the context of the project, between 0 and 1, such as the sum of weights to be equal to 1, where,

$_k \epsilon (0 \div 1)$ and $\sum p_k = 1$.

For weighting the criteria, using the judgment, the weights are proposed in the table 3.

Table 3 Weighting the criteria

No. criterion	The criterion	Weight *p*	Symbol
1	Investment cost	0.05	p_c
2	Sources of investment financing	0.15	p_f
3	Technical parameters (operating)	0.2	p_t
4	Environmental indicators	0.25	p_m
5	Economic and financial indicators	0.15	p_e
6	Investment risks and uncertainty	0.1	p_r
7	Advantages of green investment	0.1	p_a
	Total	1,00	

Stage 6 The calculation of the eco-efficiency

The calculation of eco-efficiency value is made in the tabular form by investment options.

The average score of the criterion is multiplied with the criterion weight and the criterion value is obtained. The criteria values are added together and the eco-efficiency value corresponding to each option is obtained.

The eco-efficiency option value is the sum of the arithmetic average of each option multiplied by the weighting of the criterion.

$$E_eO_i = \frac{\sum_{\gamma=1}^{d} c_\gamma}{d} * p_c + \frac{\sum_{\varphi=1}^{g} f_\varphi}{g} * p_f + \frac{\sum_{\eta=1}^{h} t_\eta}{h} * p_t + \frac{\sum_{\mu=1}^{v} m_\mu}{v} * p_m + \frac{\sum_{\lambda=1}^{w} e_\lambda}{w} * p_e + \frac{\sum_{\tau=1}^{x} r_\tau}{x} * p_r + \frac{\sum_{\delta=1}^{y} a_\delta}{y} * p_a \quad (2)$$

Where: E_eO_i = the eco-efficiency of the option *i*

Stage 7 Determining the condition of the decision-making and selecting the option (green investment decision making)

We define the minimum threshold *Q* and we select the most favourable option, respectively the option that has achieved the maximum value of the eco-efficiency (E_eO_i max). It is

recommended that the minimum threshold Q to take the value 3 in order to satisfy at least the relevant impact condition (table 2).

The green investment strategic decision is taken as the following:

$$D_{gi} = \begin{cases} \text{if } E_eO_i > Q \text{ and } E_eO\text{i max; select the green investment project} \\ \text{if } E_eO_i = Q \text{ and } E_eO_i \text{ max; reassess the green investment project} \\ \text{if } E_eO_i < Q \text{ and } E_eO_i \text{ max; reject the green investment project} \end{cases} \quad (3)$$

The investment decision is taken according to the eco-efficiency obtained for each investment option. The option with the highest value is selected, if it is above the threshold. If this threshold is not achieved then the process starts again from the beginning by selecting other investment options. If the eco-efficiency obtained is equal to the threshold the project is analyzed and the necessary corrections are to be made.

CONCLUSIONS

The *Model of decision-making based on eco-efficiency in the green investments strategy* (DEGIS) is based on the judgment and experience of the enterprise managers and professionals or external consultants and provides a useful framework for decision making in the green investment projects.

It is assumed that the projects fall within the overall strategy of the company and they are also already made or anticipated. By applying the proposed model we can select the most suitable project to the company strategy and to the strategic objectives of the green investments.

Being a simple and easy to use model, based on solving situations encountered in the management practice, it can be applied in any field of the green industry. DEGIS model was tested in a company in Romania producing electrical motors with two options for the projects.

After testing the model the following limits resulted: the unique assessment of scores and weights associated with the criteria and the use of only two options of proposed projects.

Solving the model limits and testing it by a sensitivity analysis to allow rapid changes in forecast scenarios and in weighting criteria can be performed on a multi-criteria decision analysis specialized soft and will lead to the development of the DEGIS model.

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