Methodology of industrial projects economic evaluation (*M.E.E.P.I.)*

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***Abstract*—**The article tries to present the contributions on the methodology of industrial projects economic evaluation (step-by-step), called (M.E.E.P.I.). The system of indicators used for the investment efficiency evaluation is the created model *V.R.Q.R.R.T.*, typical of industrial projects in Romania, that shows most clearly the efficiency of the project. Has been made and the chart of evaluation, comparison and selection of industrial projects in accordance with the methodology M.E.E.P.I. The methodology developed is used for comparing several versions and possible alternatives for the allocation of available capital; for ordering of variants of their efficiency level; for setting priorities and allocating the available funds on your optimization projects; to determine the effective policy of the investment firm; for choosing optimal variant of the multitude of possibilities being studied; for the formulation of specific requirements to the projects that are preparing.

***Keywords*—**Economic evaluation, investment efficiency, M.E.E.P.I., V.R.Q.R.R.T.;

I. Introduction

Economic evaluation of projects is an essential operation essential for the activity of investment decisions. All project solutions adopted are accompanied by calculations and technical, economic and financial analysis, for projects implemented to always be the most effective of the following alternatives and capital allocation [1], [2]. Economic evaluation of investment projects refers to economic phenomena (including financial ones) and operates with economic notions, patterns, techniques and instruments, realizing the enormous correspondence between resources and requirements, such resource consumption will be justified only by getting significant results [3].

Economic evaluation of investment projects must provide clear, relevant answers to a large number of questions, issues and concerns of investors [1], [3], [4]. Of these, the most important are presented in table I.

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TABLE I. Questions for the economic evaluation

What follows the investor through the initiation of this project?
Project solutions adopted or planned achieve the goals formulated.
What constraints exist in the choice of possible solutions identified?
What is the model of efficiency criteria and indicators that will be used to assess the effectiveness of possible solutions and how depends on the level of investment efficiency variables and parameters of possible solutions features project?
Which solutions and variants ensure the efficiency of allocated capital, analyzing the indicators and efficiency criteria, and therefore should be chosen?
How many and which of the projects analyzed must be accepted within the limits of the budget?

Economic evaluation of investment projects involves, first, rigorous estimate of the investment efforts and their correlation with income and expenditure flows. Below is presented the economic evaluation methodology of industrial projects, called the continued (***M.E.E.P.I***.), with all the steps and sub steps of this. The considered objectives of ***M.E.E.P.I.*** are [3]:

TABLE II. M.E.E.P.I. objectives

The argumentation of the utility and viability of investment project, in terms of sectoral and macro-social interests.
Verification and certification of the opportunity and the viability of the project, by on direct and indirect interests positions of the entities participating in its implementation: financing institutions, shareholders, investors, beneficiaries.
Investment decision, which maximizes the market value of the project.

II. M.E.E.P.I. steps

M.E.E.P.I. 1 - Step of planning and selection of the investment initial elements

The purpose of this step is the identification, evaluation and quantification of the investment project financial elements [5]. It is a very important step because values and the wrong interpretation of these, leads to the disastrous results of the project.

M.E.E.P.I. 1.1 - Setting the size of the project initial investment, I_j.

The project initial investment I_j is represented by the value (size) of the capital required for the realizing of project. The components which give the initial investment can be: the purchase price of all fixed assets, employees wages costs, costs related to the project functionality test, costs with current assets. The initial investment will be played through the

summation of all these costs, but whether the investment will be spent over several years, to be able to determine the value of the initial investment will have performed update calculations.

$$I_j = I_1(1+k)^{d-1} + I_2(1+k)^{d-2} + ... + I_h(1+k) + I_{h+1}, \quad (1)$$

where:

d - The maximum duration of realizing the project, years;

I_1 - The first trance of investments, corresponding to construction first year;

I_h - The trance investment corresponding of year *h*;

I_{h+1} - The last trance of investments, corresponding to construction last year;

Thus, for a project with three consecutive years of funding (*d=3*), the amount of investment will become:

$$I_j = I_1(1+k)^2 + I_2(1+k) + I_3. \quad (2)$$

For the calculation of the initial investment is used a preliminary discount rate *k*, standard, known for the project domain and in the M.E.E.P.I. 1.2 will be determined an exactly rate *k*. If the difference between the preliminary and the calculated *k* is greater than 1% will return to M.E.E.P.I. 1.1 and will recalculate the amount of initial investment.

M.E.E.P.I. 1.2 - Setting the discount rate, *k*

If the discount rate is higher, the more values of economic indicators calculated shrinks and therefore will be removed some types of projects. In fact, the discount rate is subject to the financial situation of the investor.

If the investment value is from own sources, the discount rate is established on the basis of the average profitability of the funds invested in the period immediately prior to the project [6]. If financing is done from several external sources, the discount rate of must be brought to a weighted average size of different sources capital costs, adding a risk margin [3], [7]:

$$k = k_1 + \chi, \quad (3)$$

where:

k - Interest rate applied by the lender including the margin of risk;

k_1 - Monetary market interest rate without risk of capital borrowed;

χ - Margin of risk (the amount of additional risk premium assumed through investments in certain industrial projects types, more or less risky);

If the project is finances through bank loan from a single source, the discount rate shall be:

$$k = k_1 + (2-4\%). \quad (4)$$

M.E.E.P.I. 1.3 – Setting the available cash flows, CFD_h

In case of investment projects economic evaluation will take into consideration the cash flows generated by these projects (estimated analyze characterized by uncertain values of the terms taking into account). For available cash flow calculation, in any year *h* of life project CFD_h, it starts from a profit and loss account of the investment, which also must be estimated as precisely (estimates for incomes and project future payments) [3], [8]:

$$PN_h = PB_h(1-16\%), \quad (5)$$

where:

PN_h - Net profit after tax;

PB_h - Gross profit from the project operation (estimate);

16% - Taxation of gross profit share;

$$CFD_h = PN_h + A_h - Ce_h, \quad (6)$$

where:

Ce_h - Economical growth formed of immobilizations variation on *h* year and net current assets variation from net debt;

A_h - Depreciation for the *h* year for the project new assets;

In any industry, when it determines the level of available cash flow, risk is calculated and it performs due to uncertainties: financial risk and business risk. It must accentuate the idea that, if possible, it can preview the amount of available cash flow only for the project analyzed. Usually, however, it is very hard to delineate the influence of a single investment project of the whole portfolio of projects of industrial enterprises.

M.E.E.P.I. 1.4 Setting the life cycle of the project, *n*

For setting the project life duration are taken into account more concepts, as follows: technical duration of project, the accountant duration, the commercial duration and use the legal duration of the project. In practice the four durations will not ever be equal. That's why in the calculations for determining the efficiency of industrial projects, will be used the duration considered representative for the projects examined [3], [9], [10], [11]. In fact, in the current economic crisis the estimate preview periods bigger than 5-7 years, does not lead to reliable results for investors. For longer projects may equivalence the future cash flows with residual values equivalent to the times *h=5-7*.

M.E.E.P.I. 1.5 Setting of project residual value, VR_n

The residual value represents the amount, which can be recovered in fixed assets taken out of operation at the end of their normal life cycle (*n*) [13]. In fact, the residual value can be determined according to the equation 5:

$$VR_n = \frac{CFD_{n+1}}{(k-f)}, \quad (7)$$

where:

CFD_{n+1} - Cash flow from the next year following the expiration of the reference period (*n*);

k - The discount rate of project, $k > f$;

f - The average annual growth rate estimate for the project cash flow;

According to M.E.E.P.I. 1.4 the maximum duration of life for predictions is $n \leq 7$, but if it is considered a machine with a normal depreciation period (n = 10), the residual value equivalent to cash flows generated in the years, which overtakes the period prediction (8, 9, 10), shall be determined as follows:

$$VR_{ech.} = VR_7 = \frac{CFD_8}{1+k} + \frac{CFD_9}{(1+k)^2} + \frac{CFD_{10}}{(1+k)^3} + \frac{VR_{10}}{(1+k)^3}. \quad (8)$$

M.E.E.P.I. 2 – Step of economic evaluation according to the model *V.R.Q.R.R.T. [3]*

The indicators that show the economic efficiency of a project, are considering the investment effort and next estimated financial effects (these are quantitative characteristics, measurement parameters with the help of which one is expressing economic efficiency level). Since these values vary from one project to another, there is not a single model for determining the economic efficiency of an investment project in any situation (there are situations where the application of several indicators lead to inconsistent results).

In industrial projects, implemented in Romania from the beneficiary's own project funds or bank loans, it proposes the following economic evaluation model consists of the following indicators (*V.R.Q.R.R.T.*), outlined below. Were chose these indicators in the model because they reflect the best economic efficiency of industrial projects and quantify the main worry of investors in the current economic crisis.

The ***V.R.Q.R.R.T*** model is composed of:

- Net updated value, *VAN(k%)* ;
- Static and dynamic economic performance, *RE, RE'*;
- Ratio between income/ expense total updated, *Q*;
- Internal rate of return, *RIR*;
- Internal rate of return modified, *RIRM*;
- Duration of capital recovery static and dynamic, TR_{static}, $TR_{dynamic}$;

M.E.E.P.I. 2.1

VAN is the first indicator that can appreciate the attractiveness of certain types of projects in order to make the investment decision, accept/reject; therefore it should not be excluded from any system of indicators.

$$VAN(k\%) = \sum_{h=1}^{n}(PN_h + A_h - Ce_h)(1+k)^{-h} =$$

$$= \sum_{h=1}^{n}(CF_{functionare} - Ce_h)(1+k)^{-h} = \quad (9)$$

$$= \sum_{h=1}^{n} CFD_h(1+k)^{-h}.$$

M.E.E.P.I. 2.2

To determine static and dynamic economic efficiency, RE, RE', of the project departs from forecasting the total profits, P_t, it will generate the project and the amount of the total initial investment, I_j.

The static economic efficiency is express depending on the life duration of the project [8]:

$$RE = \frac{P_t}{I_j} - 1 = \frac{P_{h(medium)} \cdot n}{P_{h(medium)} \cdot TR} - 1 = \frac{n}{TR} - 1. \quad (10)$$

where:

P_t - Total profit;

$P_{h(medium)}$ - Average value of profit;

For the calculation of dynamic economic efficiency, *RE'* it will use the updated values of profit and the initial investment:

$$RE' = \frac{VA(P_t)}{VA(I_j)} = \frac{\sum_{h=1}^{n} P_h \cdot (1+k)^{-h}}{\sum_{h=1}^{n} I_h (1+k)^{-h}}. \quad (11)$$

M.E.E.P.I. 2.3

The ratio between the incomes and the total expenditures updated, *Q* is used as a ranking criterion of investment projects, because every investor or the beneficiary of the project wants to maximize revenue per cost unit [10].

$$Q = \frac{\sum_{h=1}^{n} V_h (1+k)^{-h}}{\sum_{h=1}^{n} (I_h + CE_h)(1+k)^{-h}}. \quad (12)$$

To be able to analyze the space of admissible solutions of this indicator in the case of several types of projects, it is proposed to be done graphics method. Assuming that there are 8 variants of the same project, for each variant we will have a report Q_i $(Q_1 \ldots\ldots Q_8)$.

It is assumed that the beneficiary of the project (the investor) has a minimum value of revenue ($\sum VA(V_h)_{(\min)}$) and a maximum value of expenses that he will accept ($\sum VA(K_h)_{(\max)}$), these two restrictions will make a limited space in which they can search for optimal solutions, as shown in fig. 1:

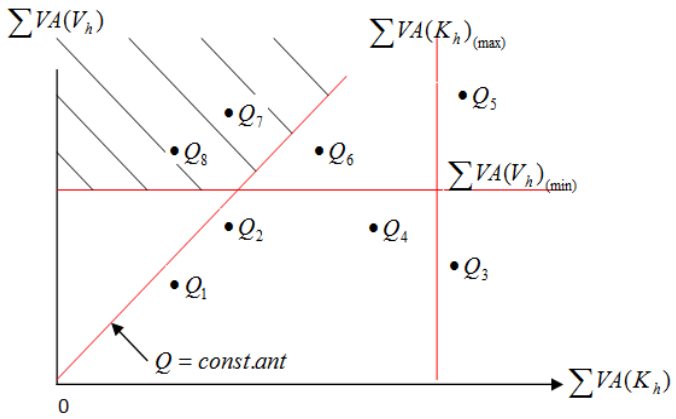

Fig. 1 Q_i optimal solutions of a project

In figure 1, the bisector $Q = \text{constant}$ relates $\sum VA(V_h) = \sum VA(K_h)$. The optimal solutions of the project are represented by the hashed area, so the only variants that can be implemented are Q_7 and Q_8, according to the investor's restrictions.

Conclusions: the value of the discount rate *k* is smaller, $k \Rightarrow 0$, the value of the indicator *Q* will be higher (*k=0→Q=maxim*); if the value of the discount rate rises, the *Q* indicator value will lower and thus may be less than one.

M.E.E.P.I. 2.4

The *RIR* level shall be determined by successive attempts, because it is not a relationship of direct calculation. Thus, it will be calculated *VAN* at different discount rates *k* and almost close rate will reach *k*, for which *VAN=0*. Because it uses linear interpolation, it is recommended that $\Delta k = k_{\max} - k_{\min}$, to be not higher than 5-7%.

$$RIR = k_{\min} + (k_{\max} - k_{\min}) \cdot \frac{VAN(k_{\min})}{VAN(k_{\min}) - VAN(k_{\max})}, \quad (13)$$

where:

$k_{\min}$ - The lowest discount rate for that: $VAN(k_{\min}) > 0$;

$k_{\max}$ - The highest discount rate for that: $VAN(k_{\max}) < 0$;

Selecting an investment project after maximum RIR criterion requires that all projects examined to have the same economic life; otherwise the RIR will achieve an incorrect ranking of projects. Internal rate of return enables the comparison of investment alternatives and variants, considering the staggering in time investment, cash flow and profits. RIR does not involve establishing beforehand the discount rate as the calculation involves the VAN.

M.E.E.P.I. 2.5

The internal rate of return modified *RIRM* represents a function $f(k)$ of the discount rate *k*, for which the future capitalized values of the initial investment and the cash flows becomes equal at the end of the project life cycle [3, 4, 8]:

$$[1 + f(k)]^n \cdot VA(I_j) = \sum_{h=1}^{n} CFD_h (1+k)^{n-h} \Rightarrow \quad (14)$$

$$[1 + f(k)]^n = \frac{\sum_{h=1}^{n} CFD_h (1+k)^{n-h}}{VA(I_j)} \Rightarrow \quad (15)$$

$$RIRM = f(k) = \left[\left(\frac{\sum_{h=1}^{n} CFD_h (1+k)^{n-h}}{VA(I_j)} \right)^{\frac{1}{n}} - 1 \right] \cdot 100. \quad (16)$$

$$RIRM = f(k) = \left[\left(\frac{\sum_{h=1}^{n} CFD_h (1+k)^{n-h} + VR_n}{VA(I_j)} \right)^{\frac{1}{n}} - 1 \right] \cdot 100. \quad (17)$$

M.E.E.P.I. 2.6

Both in theoretical considerations, but also in practice the duration of capital recovery is calculated in static and dynamic approach to the investment process and it is express in years. In fact, the duration of investment recovery is the ratio between the value of the initial investment and an annual volume of benefits considered (which may be profit, constant cash flow or medium etc.) [2], [3], [12].

$$TR_{static} = \frac{I_j}{\frac{\sum_{h=1}^{n}(PN_h + A_h - Ce_h)}{n}} = \frac{n \cdot I_j}{\sum_{h=1}^{n}(PN_h + A_h - Ce_h)}, \quad (18)$$

$$TR_{dinamic} = \frac{n \cdot I_j}{\sum_{h=1}^{n} CFD_h (1+k)^{-h}}. \quad (19)$$

TABLE III. CONCLUSIONS OF V.R.Q.R.R.T. MODEL

Economic evaluation scope	Indicators					
	VAN	*RE, RE'*	*Q*	*RIR*	*RIRM*	*TR*
Comparing the benefits with the costs	x	x	x	x	x	
Determination of the minimum acceptable investment for an investment project.	x		x			
Maximizing the benefits.	x		x	x	x	
Comparison of equivalent projects.	x			x	x	x
Selecting the best projects in the case of self financing or limited credit.			x	x	x	
Determination of maximum acceptable interest for projects through loans.				x	x	
Determination of payback through benefits.		x				x

M.E.E.P.I. 3 – Step of project sensitivity analysis

For a more accurate estimate of the economic efficiency of an industrial project, it is necessary to assess the effect of changing the initial investment element values in the input model on the efficiency indicator (*VAN, RIR, Q, RIRM* etc). This is accomplished in a sensitivity analysis [3], [15].

By **M.E.E.P.I. 3** it follows:

The sensitivity analysis of the project indicators to some variations of parameters;
Determination the critical profitability of the project in terms of parameters variations;
Apparition probabilities of favorable or adverse events;
Determination of the external project risks (systemic risks, market risks, etc.);
Identification of critical variables that significantly influence the results of the project;
Effects of selected items variations (costs and benefits) on *VAN, RIR, Q*;

In fact, is tested the stability of V.R.Q.R.R.T. model and the stability of financial results at certain variations of revenues and expenditures within the industrial project with consideration of several possible variations: increase expense with the necessary equipment and construction project, the increase in operating expenses, minus the income variation, etc. (these are periodic variations).

Thus, in industrial projects implemented in Romania it is recommended to test the indicators stability at the costs and incomes variations (5-10%) of the entire estimate period [3]:

STEP 1: The initial investment amount and operating expenses are calculated increasing with 5% and 10%, and the annual revenues value and decreasing with 5%.

$$I_j^{'} = I_j + 5\% \cdot I_j, \quad (20)$$

$$\sum_{h=1}^{n} CE_h^{'} = \sum_{h=1}^{n} CE_h + 10\% \cdot \sum_{h=1}^{n} CE_h, \quad (21)$$

$$\sum_{h=1}^{n} V_h^{'} = \sum_{h=1}^{n} V_h - 5\% \cdot \sum_{h=1}^{n} V_h, \quad (22)$$

where:

$I_j^{'}$ - Initial investment value corresponding to M.E.E.P.I 3;

$\sum_{h=1}^{n} CE_h^{'}$ - Operating expenses value corresponding to M.E.E.P.I 3;

$\sum_{h=1}^{n} V_h^{'}$ - Annual revenues value corresponding to M.E.E.P.I. 3;

STEP 2: It is calculated the gross and net profit of the project;

$$\sum_{h=1}^{n} PB_h^{'} = \sum_{h=1}^{n} V_h^{'} - \sum_{h=1}^{n} CE_h^{'}. \quad (23)$$

STEP 3: The six indicators are calculated according to **M.E.E.P.I. 2** and will result the model *V'.R'.Q'.R'.R'.T'* which must meet the minimum conditions required of indicators and *V'.R'.Q'.R'.R'.T'* values not to be much smaller than *V.R.Q.R.R.T.*

In the event that one or more of the indicators values of V'.R'.Q'.R'.R'.T' model appears below the minimum acceptable threshold (example, Q = 1, which means that the project will not produce any benefit), it is very clear that the project has a high sensitivity to variations in input parameters. At this point, managers must stop the evaluation at M.E.E.P.I. 3, and to take the massive re-evaluation of the project (starting again with M.E.E.P.I. 1).

In **M.E.E.P.I. 3** evaluation it is not recommend to consider some variants more favorable than the average estimated, because if the model V.R.Q.R.R.T already shown that the project will produce benefits, it is clear that improving conditions will lead to more good values of the indicators.

M.E.E.P.I. 4 - The performance audit of the investment project

According to the I.N.T.O.S.A.I. standards (International Organization of Supreme Audit Institutions) the *performance audit* is defined as an economy, efficiency and effectiveness audit with which the audited company use resources in order to

accomplish the objectives and responsibilities of the project. Performance audit is synonymous with the expression "value for money". Unlike the financial audit, performance audit is much broader and open to interpretations, expanding on the large periods of time. There is not only a financial exercise with certain documents, audit reports being very extensive containing comments and solutions to problems encountered by managers [14], [15]. The performance audit covers the following aspects [3], [16], [17]:

- *Economical audit* – on the activities of the administrative management in accordance with the principles, practices and policies of an appropriate management.

- *Efficiency audit* – on the use of human resources, financial or any other kind, quantifying the risks that can occur and results (its objectives may cover the time you will realize the project, product, delays and causes generating estimates of the costs/results).

- *Effectiveness of audit results* – on the objectives pursued and the estimated impact of their activities in relation to the desired impact.

Project audit represents a clear examination and accurately in detail of budget management, the degree of achievement of objectives and the sustainability of the project in order to determine the level of performance, identifying the unrealized causes of the proposed results and offers solutions in order to increase the level of performance. The audit may be required by the funder or by the beneficiary of the project, is binding realized at projects financed from the budget in the design stage, during or after the conclusion of the project. The results of performance audit projects set up in an Audit Report.

It should be noted that in Romania, has been demonstrated over the past 25 years, that not only the management is the main cause of failure started and unfinished projects, but also those who conceive, or endorse, authorizes and controls the works. Thus it is essential that the audit projects to be done in each stage of the project: after the phase of conception, before obtaining permits for construction and after the reception of final works.

III. M.E.E.P.I. CHART

For each of the four stages of economic evaluation of the industrial projects, was presented the steps that must follow for their application, the data and information required, the tools and methods for management as well as the types of decisions to be taken by the company management [3].

Methodological proposal may be in a systematic and integrated method of management of industrial investments, to answer the criteria of economic and financial efficiency of the entire investment activities of an entity. Thus, the application can be connected to the four stages, as well as the accumulation of important experiences for managers and evaluators of projects, which can improve the methodology for assessing, reducing the implementation of investment projects ineffective risk, or with a high risk.

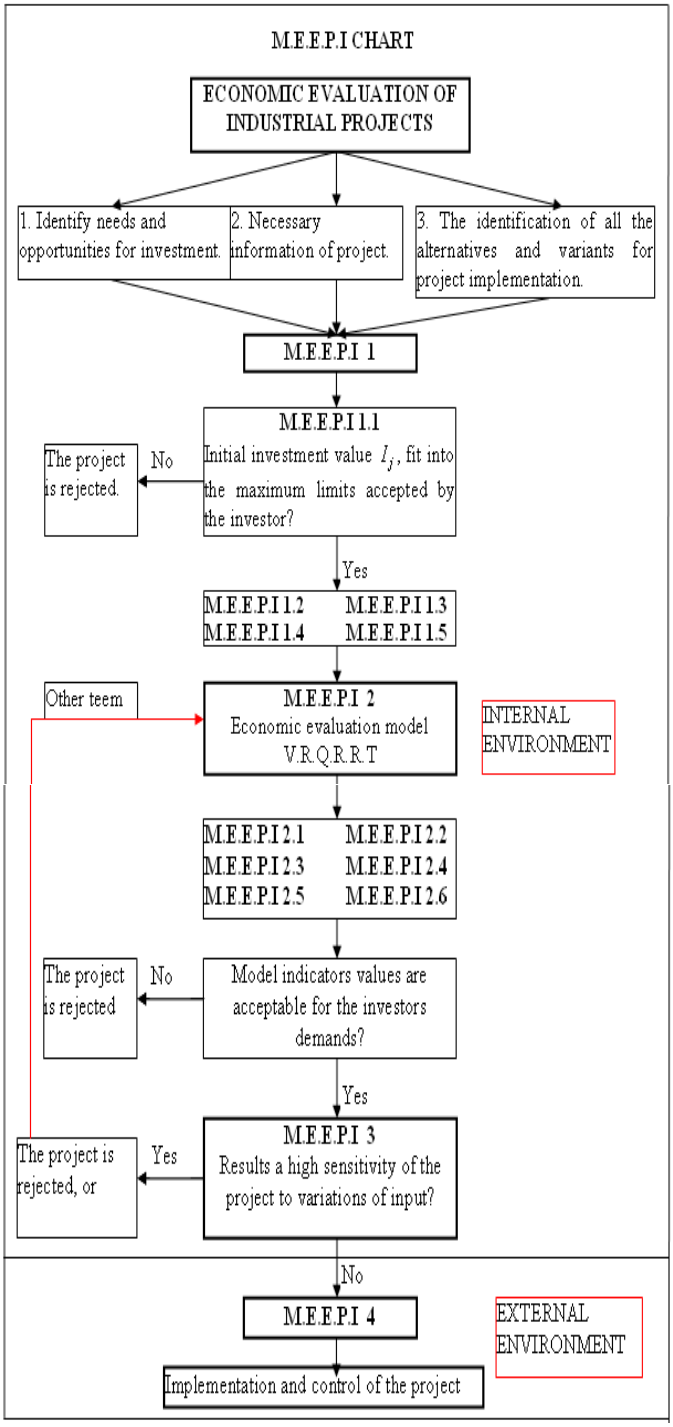

Fig. 2 Scheme of M.E.E.P.I.

According to *V.R.Q.R.R.T.* model it considers that the dynamic approach is a technique better than the static approach as regards consideration of these indicators/criteria. Currently, the most used methods are those which require an analysis based on time factor influence on the profitability. In fact it is proposed the model of economic evaluation *V.R.Q.R.R.T.* achieved from six efficiency economic indicators.

According to the M.E.E.P.I. stages shown above will be made, an assessment scheme, comparison and selection of variants/industrial projects, represented in fig. 2 [3].

Analyzing and diagnosing the economic environment are very important components of the strategic management process that ensures the organization's success in the competitive market (usually placed in feasibility studies). It is recognized that all organizations try to identify their strengths and weaknesses, opportunities and threats of the competitive environment (SWOT diagram). Often, however, lose sight of the fact that a combination between these factors can lead to obtaining and choosing certain strategies.

IV. Conclusions

The procedure for selection of investment projects is a problem features each organization, and the most important thing is the evaluation impact of enterprise-economic environment. Although there can not be quantified, this evaluation is used to determine the organization's development strategy and contains three important moments:

- Determination of the organization objectives and identifying investment opportunities;
- Diagnostic analysis of the organization which seeks to determine strengths and weaknesses;
- Analysis of the economic environment in which the organization operates.

The main stages in the evaluation and selection of industrial investment projects are as follows:

a) Generation of all possible investment variants and selecting the initial elements of investment (**M.E.E.P.I. 1**);

b) Economic evaluation of variants/ industrial projects (**M.E.E.P.I. 2**);

c) Sensitivity Analysis of variants/ projects (**M.E.E.P.I. 3**);

d) Performance Audit (**M.E.E.P.I. 4**);

e) Implementation and monitoring the project;

Generation of all investment variants is a decentralized problem that allows being developed investment proposals at all levels of enterprise. The lower levels will propose replacement investment, modernization or expansion, and the upper levels will have the responsibility of some proposals for strategic development projects. Thus, in this stage, each project must be accompanied by a commercial, technical and financial study, to justify the appropriateness and sustainability of the investment.

Also managers and initiators of projects are involved in the decision-making process from the standpoint of how the funds are spent. Knowledge of the factors that influence the profitability helps managers in channeling resources of the company's most profitable investment. In many enterprises has given up at the idea that the director gives a verdict about the economic viability of investment projects proposed, but this does not mean that they are not used in evaluation techniques and that does not take into account aspects of the marketing, production and human resources of all projects. The result of this stage is to develop an investment plan and funding. This document presents the synthesis of selected investments and their financing.

The selection of investment projects is carried out based on financial criteria, after establishing the initial elements of the investment and comparing them, but taking into account direct investment policy priorities. It refers to choosing cost-effective investments depending on the resources that can be allocated to them. Investment decision is a decision of the general policy of the enterprise. It requires in enterprises an organization system that allows a good circulation of the information and ensures the coherence of decisions. The investment decision hires the enterprise over long periods and requires the establishment of funding policies in order to obtain the necessary funds. It is considered the allocation of available capital or collected.

Thus, this article provides important contributions to economic evaluation of projects by:

- Development of step-by-step methodology for evaluating solid economic industrial projects *M.E.E.P.I.*;
- Research and grouping of economic indicators in a system of indicators *V.R.Q.R.R.T.*, typical to industrial projects, which shows most clearly the effectiveness of the project; presentation of the methodology of calculation of the indicators, the comparison and selection of projects according to these.

Investment decision is a decision of the general policy of the enterprise. It requires an enterprise system, which allows a good flow of information and ensure the consistency of decisions. The investment decision hires the enterprise for long periods and requires completion of funding policies in order to obtain the necessary funds.

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