

# Performance, Value and Penetration of Real Options into the Capital Budgeting Processes of Czech Companies using AMTs

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**Abstract**—Paper deals with topic of capital budgeting methods that are currently used by Czech companies that implemented some of advanced manufacturing technologies (AMTs). The main aim of a paper is to analyse and propose successful implementation of real options into the value creation processes where other performance measures and concepts are used in their mutual synergy. Research is based on results of analysis that strived to find out the structure of currently used capital budgeting methods, managerial concepts and other important perspectives of competitiveness within a group of Czech companies. Supporting goal is to analyse and identify the barriers in penetration of real options to capital budgeting processes of Czech companies and describe impacts of flexible investments on enterprise value.

**Keywords**—Performance, analysis, real options, AMT, economic value added, balance scorecard, value, capital budgeting

## I. INTRODUCTION

Mechanism of investment justification is a key process for companies' future competitiveness and its performance. The following paragraphs and parts of a paper discuss used concepts, linkages to the value of a company and flexibility issues.

Real Options were firstly mentioned by [22], who created a sort of framework for decision-making with a focus on options to expand and to contract a project. Since 1977 there were just few successful practical implementations of real options until [31] published a comprehensive book called Real Options. The book contains both a theoretical overview and several practical examples (case studies) as well. Thanks to the comprehensive focus of the book can be said that it contributed greatly to the spread of real options towards practice. Even more practically oriented book followed in 1999 by the authors [1]. Relatively less mathematically complicating publication was introduced by [Copeland]. Thanks to mentioned and as well as other publications became

real options more penetrated and used concept [12]. It should be noted at this point that none of the previous books and articles does not and never tried to substitute for discounted cash flow method as a more accurate and accepted method of investment decision. Nevertheless, in the words of [10] the application of discounted models in some cases is not only inappropriate, but it is very inappropriate and misleading. According to [20] real options represent a tool that allows managers to properly evaluate the investments with a large degree of involved uncertainty. Appraising the level of flexibility as a measure of uncertainty turned out to be the key question [3, 19]. Real options could be used as a beneficial tool for valuing managerial flexibility to adapt decisions in response to unexpected market developments and changes. Companies create shareholder value by identifying, managing and exercising real options associated with their investment portfolio. The real options method applies financial options theory to quantify the value of company's management flexibility in a world of uncertainty and frequent changes. If used as a conceptual tool, it allows management to characterise and communicate the strategic value of an investment project and accept them [21]. Traditional methods (e.g. Net Present Value = NPV) fail to accurately capture the economic value of investments in an environment of widespread uncertainty and rapid change. For instance, [11] argue that traditional performance measures are not applicable for some investments, especially those with higher level of uncertainty etc. The real options method represents the new technique for the valuation and management of strategic investments [12]. The real option method enables corporate decision-makers to leverage uncertainty and limit downside risk [21]. Just as an option gives its owner the right - but not the obligation - to take a particular course of action at some time in the future, flexibility embedded in capital investment projects and company strategies allows managers to take a staged approach to corporate strategy and react to changes in the business environment, so they can limit downside losses while fully capitalizing on upside potential opportunities [4], [27], [29]. [5] present and describe several types of real options in relation to the different investment projects.

Over the last two decades there has been increasing interest in the development of alternative approaches to management accounting and performance measurement. One of the biggest

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impacts on performance measurement during this period was Balanced Scorecard (BSC). A common theme in the newer integrated performance models or frameworks has been determined as an attempt to tie performance metrics more closely to a firm's strategy and long-term vision [32].

BSC [15], [16] is a model which integrates financial and non-financial strategic measures. It is distinct from other strategic measurement systems in that it contains outcome measures and the performance drivers of outcomes, linked together in cause-and-effect relationships making the performance measurement system a feed-forward control system. The scorecard translates the vision and strategy of a business unit into objectives and measures in four different areas:

- financial,
- customer,
- internal-business-process and
- learning and growth perspectives.

[15], [16] as originators of the concept have promoted the concept further with the idea of strategy maps representing visual tool which is mapping the cause-effects relationships through four mentioned perspectives and converting also intangible assets into tangible outcomes. Strategy maps are beneficial tool for general cause-effect analysis and are used in following parts.

The Economic Value Added (EVA is the registered mark of Stern Stewart&Co) may be an appropriate indicator for the financial perspective in BSC. It includes the cost of capital and may be identified through the use of generators at all levels of the value of the company. However, in so far as EVA is a financial measure it presents the risk of excessively focusing managerial attention on short-term profits. For this reason, integrating EVA and BSC can be considered to be a more useful approach. This is because BSC is a tool designed specifically to eliminate the risk of pursuing short-term profits from enterprises [2].

Manufacturing technology moderates the relationship between strategy and organizational performance. Thus manufacturing technologies need to be consistent with business strategy. Successful deployment of technology helps to build a competitive advantage thereby enhancing organizational performance. Effects at level of positive and negative impacts on financial performance of firms can be explored and measured as well [23]. Advanced Manufacturing Technology (AMT) refers to the family of technologies that include computer-assisted design and engineering systems, materials resource planning systems, automated materials handling systems, robotics, computer numerically controlled machines and other manufacturing advanced systems. However the relatively high cost of AMT and the moderate-to-high risk involved in adopting these technologies underscore the need for investment justification. Therefore management is very often placed in a dilemma in that on the one hand they wish to invest in new technology, such AMT, but on the other hand they find it difficult to justify the capital expenditure

using the traditional appraisal techniques. The conventional financial evaluation methods are well-established, well documented, while the methodologies for the evaluation of the strategic, intangible benefits are less formalized and often less understood [30]. Combination of modern management concepts can be used [14] and synergic effects that can be gained by using these concepts together may appear [17]. To justify advanced manufacturing systems, [26] based on previous work, provides a comprehensive bibliography and reviewed literature concerning investment appraisal techniques for AMT and provides an excellent framework. As a most convenient management tool for justifying AMT seems to be combination of net present value and real options [21], [31].

## II. PROBLEM FORMULATION

To run the company towards higher market value require sophisticated management control over all perspectives of business. As a convenient measure of a financial effectiveness seems to be concept of EVA. To be able to increase the value of EVA only high-performance investment can be introduced. Discounted model are well established and used while real options are more accurate especially during the time of higher uncertainty. Goal is to analyse the level of penetration of each capital budgeting method and identify barriers that prevent from implementing the theoretically improved concepts in Czech practice.

### A. Analysis of Capital Budgeting Methods in Czech Republic

The Czech Republic entered strong competitive multinational environment in 1989. Since then, the companies in the Czech Republic have been competing through the price, quality and speed with competitors from all around the world. To meet these competitive challenges is of course important how efficiently firms transform their inputs into the desirable outputs. Not only during the time of transformation help investments to modernisation and automation to meet advanced customer requirements. The Government aims to create attractive investment incentives to foreign and domestic investors [28].

Following table no. 1 presents results of investigations carried out through prepared questionnaires. As a micro-enterprise was considered enterprise that had less than 10 employees. Small-enterprise was represented by these who had 10-49 employees. Enterprises in the range from 50 to 249 employees were taken as medium-sized businesses. Enterprises with more than 250 employees make up a group of large enterprises. Companies were asked to select criteria according to which they perform effectiveness valuation. Multiple choice answers were ready in accordance with the structure of Tab.1. Usable answers were obtained from 393 companies. Size, age and specialization is known and can be used as filter parameter.

Table 1 Capital budgeting method's "popularity"  
Source: author's analysis

Methods	Micro	Small	Medium	Large	Total
Costs-based Criteria	51%	66%	73%	60%	65%
Net Present Value	17%	15%	22%	50%	27%
Real Options	2%	0%	0%	5%	2%
Payback Period	46%	61%	71%	82%	69%
Return On Investment	27%	56%	52%	55%	51%
Internal Rate of Return	7%	13%	15%	43%	21%
Comparative Analysis	22%	30%	28%	26%	27%
Intuitive Decision Making	41%	33%	40%	27%	35%
Other criteria	0%	2%	4%	0%	2%
Do not evaluate investments	17%	11%	3%	2%	6%

Among "other criteria" appeared such methods as EVA, DCF and other special techniques. Anyway their frequencies appeared to be negligible. The reason why the sum of percentage in each column is not equal to 100 % is that the companies usually prefer more than one method. The results are not very satisfactory, because it turned out that the companies favour static methods to dynamical ones.

The leading method is payback period, followed by costs-based criteria and ROI (Return On Investment). Unfortunately the concept of Real Option is not common at all and real options are the least widespread tool that is almost never used. Interesting finding is that the bigger the company is more popular the payback period method is. The same dependency was identified for NPV (Net Present Value) and IRR (Internal Rate of Return).

### B. Foreign Analysis of Capital Budgeting Methods

Interesting research at that particular area was carried out by authors [6]. The following table no. 2 shows, which criteria were among the most widely used in the comparison between 146 English companies and 117 American companies.

Table 2 Capital budgeting methods preferred in England and the USA  
Source: Burgess and Gules [6]

Methods	UK	USA
IRR	55%	56%
NPV	52%	41%
Discounted Payback Period	54%	65%

Discounted Cash-Flow	5%	3%
Payback Period	69%	39%
Accounting Rate of Return	20%	19%
Other	5%	5%

The level of penetration of Payback Period method in UK is exactly the same as in the Czech Republic. Authors [10] also pointed out that Czech's companies don't support NPV and IRR in comparison to companies in UK and the USA.

### C. Analysis of barriers in penetration of real options to capital budgeting processes of Czech companies

According to the author's analysis and own research is possible to present following results. Causation could be seen in two general factors:

- general – relatively low level of NPV a IRR,
- individual.

Real options represent additional value (value of future inbuilt flexibility) to the value calculated through NPV concept [21], [31]. Without broader application and implementation of NPV and IRR is impossible to await greater popularity of real options. Barriers on individual level were closely analysed in long-term cooperation with 10 companies. Level of importance of a single identified factor is stated in the following table no. 3.

Table 3 Individual barriers in the order of their importance  
Source: author's analysis

Order	Barrier in Real Option's Implementation
1	Method Complexity
2	Prediction of Inputs
3	Difficult Interpretation
4	Distrust in Intangible Values
5	Lack of Complex Software Solutions
6	Other

As a main barrier towards option implementation is seen method's complexity. Firms feel that implementing options to their financial valuation system is not an easy task and requires more effort than any other metric. Once the processes are set and option implemented, problems concerning prediction of needed inputs remain. Problems with correct result's interpretation, distrust in immaterial values and lack of complex software were identified as well.

### III. IMPLEMENTATION OF REAL OPTIONS INTO THE VALUE CREATION PROCESSES OF A MODEL COMPANY

Investment appraisal is with no doubt one of the key challenge for financial management. Wrongly evaluated investment might be future fortune or total disaster for a firm. More than 40% of analysed Czech companies changed attitude and system of performance management [author]. The need

for a management concept that will cover customer's and other stakeholder's requirements is clear. For desirable process complexity is for purposes of our analysis used concept of BSC with its strategy map. Processes involving real options implementation can be seen in the figure no. 1 below. Methodological description of the contents of four fundamental steps from the figure no. 1 is covered in the following subchapters.

**A. The Knowledge (Ability) Base / process 1**

Knowledge base implies ability to identify the possibility of using real option to support decisions on acceptance or rejection of the project. The basic prerequisites for deriving the benefits from investments are ready and well trained employees. A prerequisite for further extension, narrowing, interruption or cancellation of the project during its life is the ability of employees to prepare the project so that these potential changes (options to change anything) were carried out without additional and unnecessary costs. The lack of know-how, knowledge infrastructure, at this stage of a project could scale up the level of a risk and due to the firm's inability to work with involved flexibility would lead to project rejection.

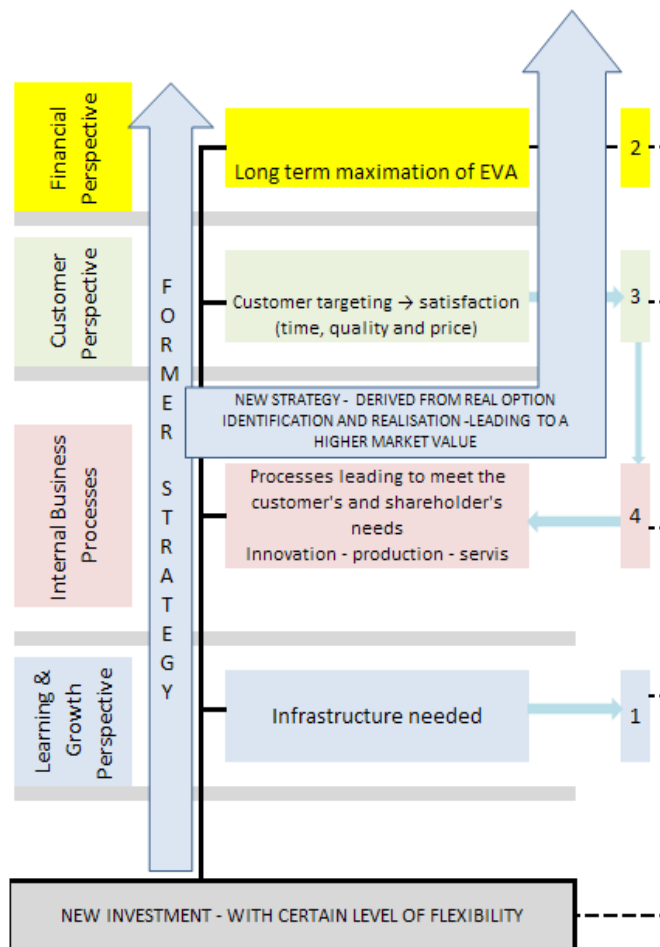


Fig. 1 Implementation of Real options from the strategy perspective – 4 key processes  
Source: author's analysis

**B. Valuation of Investment's Flexibility / process 2**

Investment is made it meets the required level of performance. Classical methods of capital budgeting evaluate projects in terms of their liquidity, risk and time factor. These methods don't include the fourth dimension, flexibility. If conventional methods produce negative results, we should not accept an investment. Nevertheless it happens in practice. Firms accept projects with a negative effect on their market value (according to the NPV concept). Why? To approve the investment that for the first sight appears as unprofitable, we must appreciate not only the traditional financial performance, but also we must be able to express the value of involved flexibility, which essentially means to implement real options to support investment decision-making. New calculation is needed to be adopted.

$$NPV_{new} = NPV_{old} + option\ value \quad (1)$$

Traditional NPV includes the assumption that investments will be feasible in complying with the original strategy, which appears in the beginning as most appropriate. Contrary to option value which consist of the value of future potentials and company's ability to transform those potential to the value. Closer procedure of correct flexibility valuation is presented in the following figure no. 2.

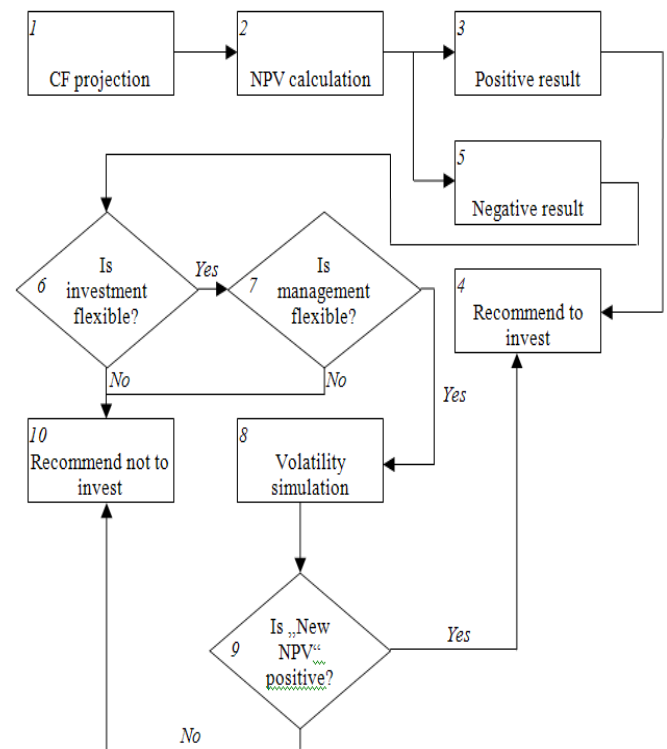


Fig. 2 Key steps in project valuation including real options  
Source: author's analysis

Description of each step is as follows:

1 – Cash-flow projection – firstly is generally needed to create a plan of future cash-flows (CFs) for chosen

investment. Time span for that section depends on the lifetime of investment.

2, 3, 4, 5 – *NPV calculation* – based on the details from the CFs plan is calculated NPV. Regarding generally accepted rules for rejecting the projects with negative NPV and contrariwise.

6 – *Investment flexibility* – one of the key attribute of new investments is their flexibility and adaptability to the customer's requirements. But flexibility was not evaluated yet. Speaking about flexibility value always means speaking about positive values. We challenge this task only if NPV from the second step is negative.

7 – *Management flexibility* – if the investment is flexible it doesn't guarantee creation of real value by itself. We still need to have competent management that will be constantly able to search for possibilities on market and at the right time will use the flexibility of implemented investment and transform it to the real value. To test the level of management flexibility we arrange an indicator called "VRO" that is based on 24 parameters.

8 – *Volatility determination and an option value calculation* – if both, management and investment, are flexible than we need to calculate its value. For calculation of the value of flexibility is beneficial and recommended to use the tool of real options [6, 14]. Most of the practical problems we had to face are connected to volatility parameter assessment. Out of five generally known parameters influence volatility the final option value the most. To set volatility correctly you can use several models [6, 20].

9, 10 – *Final interpretation* – Adding value of an option to the NPV (from the 2nd step) presents „New NPV“, which is correct. For interpretation apply the same rules as presented in the step 2.

#### *Impacts of AMT Investments on Enterprise Value - Value and Performance Management of Firms with AMT Investments*

Each investment is linked, on the one hand, to a capital expenditure that we have to make in order to acquire advanced technologies. On the other hand, it is connected with cash incomes which will be earned from the investment in the long term horizon. Of course, every project, regardless of whether it involves the investment in high technologies or not, should have a positive net present value, or in other words, its internal rate of return must be higher than a company's cost of capital. Otherwise, the project would not be acceptable to the owners (it would not increase the market value of the enterprise). Unfortunately, the condition of positive net present value is no longer sufficient today. According to [25], it is necessary to approach a decision-making process in a more complex way and to consider the extent of meeting the selected strategic objectives. The internal rate of return higher than the cost of capital does not guarantee that the realization of investment will contribute to the successful achievement of the objectives

set (visions and relevant culture). On the contrary, neither the internal rate of return lower than the cost of capital should mean the categorical rejection of the investment project. As already mentioned in the section above, the main determinant of advanced technologies lies in their flexibility. Flexibility should, in a broad sense, mean the ability to adjust the project during its lifetime to changing market conditions. This characteristic of AMT investments then obviously reduces the overall risk of the project, extending its economic life, but also increases the demands on the ability of management that must develop and implement effective management tools of these systems to allow the use and further development of all these positive AMT characteristics. I will further focus in the work specifically on the use of the BSC concept and partially on the EFQM and ABC/M concepts due to mutual synergies arising from the current involvement of these tools in the company management systems.

In order to identify the impact of AMT investments on enterprise value, a modern Balanced Scorecard (BSC) concept can be used. The BSC provides a comprehensive look at the effects of the introduction of AMT into business processes, including identification of all impacts and aspects of the implementation. The AMT acquisition phase is closely related to the BSC perspective "**learning and growth**". Technically and technologically advanced technologies require higher demands on the skills, abilities and qualifications of employees. In order to use AMT investments effectively, employees must be familiar with the new IS/IT systems. The opportunity to work with more sophisticated systems means higher motivation for most employees and thus it positively affects the attitude of employees and managers to their work. It is essential to identify suitable metrics from this perspective for selected strategic business objectives.

The impact of AMT investments on other BSC perspectives of "**internal processes**" is direct and primary; therefore, the internal perspective will be analyzed in greater detail than others. The internal process perspective is strongly influenced by the use of AMT technologies. According to [13], their use may result in the saving of material consumed, reducing inventory, speeding up the production cycle, better utilization of technological equipment, accelerating development or increasing the rate of innovations. At the same time, it is possible according to the same authors to assume that these technologies will save part of the workforce as well (on the other hand, we must reckon with the fact that more skilled employees will demand higher remunerations). Therefore the result can consist of saving and overall reducing operating costs, a higher quality of final products, reduced scrap products, etc. Faster delivery of a better quality product that meets specific customer's requirements may be followed by the increase in overall customer's satisfaction. These benefits are redeemed by higher costs of advanced technologies and staff training, higher demands on the selection of competent workers, higher demands on wages and an increased risk of rapid moral and technological

obsolescence in the short term. A specific feature of the new AMT investment is also a fact that the maximum use of benefits occurs after a “deployment” phase. This delay arises from the need to learn how to use and operate the technology intuitively. The use of implemented AMT investment and its effects can be mapped using the process perspective, within which we can decompose various business processes into successive stages of a value-creating chain. Specific strategic areas affected by implemented AMT investments are divided into three basic phases - innovation, operation (production) and sales process. Benefits (impacts) of operational technologies can be effectively measured by three parameters - process costs, process quality and process duration. To measure the process costs and subsequently determine the effectiveness of the activities carried out, we can use the ABC/M concept, which allows us to express the final effect in monetary units, i.e., to compare the process costs and benefits it brings. The ABC model and its information outputs can also be a significant tool for benchmarking whose benefits can be found in a “cheaper” improvement of business processes, activities, thanks to learning from the best. The use and design of a possible implementation of selected concepts for the effective use of investments in advanced technologies in the internal processes of companies is illustrated in Figure 3 below.

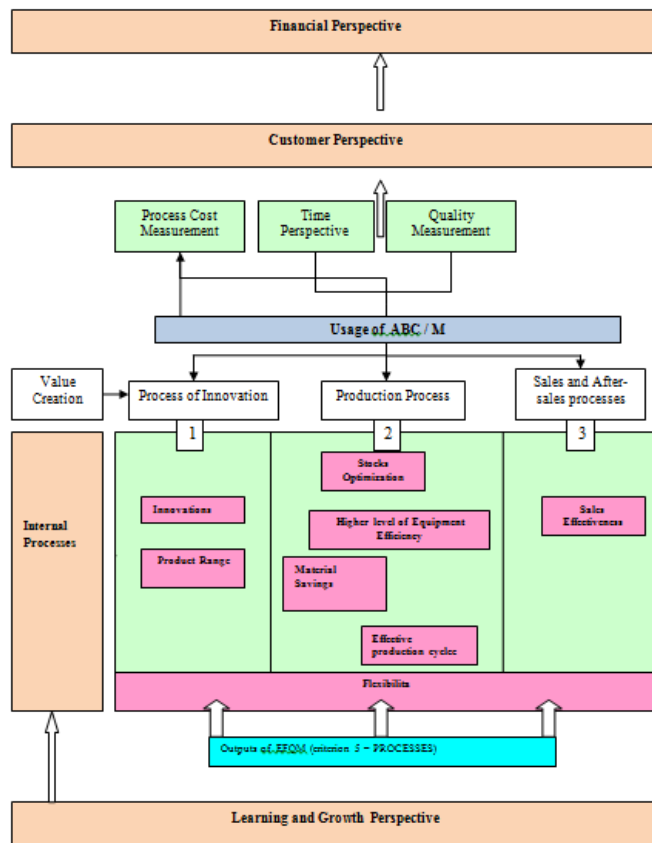


Fig. 3 Proposal for a possible implementation of BSC, EFQM and ABC/M concepts for the efficient use of investments in advanced technologies in the internal processes of companies  
Source: [24]

In the process of determining strategic objectives, it is preferable to use the EFQM model. The internal process perspective is bound to the criteria of the “processes”. Quality valuation of the processes carried out in the company will reveal strengths and weaknesses that can be removed or supported by correct setting of strategic objectives (and eventually by strategic actions).

The impact of AMT investments on “customers” perspective is evident as well. Only customers verify the validity of the changes implemented in production. If a company succeeds with customers, it is only then when it strengthens performance. In simple terms, a satisfied customer is loyal to company. Only such customers spread goodwill and attract new customers. Increasing market share is only a subsequent effect. Then the profit takes place. AMT must thus in its principle contribute to the general satisfaction of the customer (e.g., by prompt response to his/her needs and wishes, by the quality of products or services, etc.). The benefits realized in the internal perspective must be accepted and reflected positively in the customer perspective of BSC.

AMT investments mean for firms high capital expenditures at the time of the acquisition. In terms of costs, this amount incurred is recorded in the costs as an item of depreciation during the useful life of the investment. This leads to a reduction in profits and profitability ratios. AMT investments are usually covered by long-term resources (equity and long-term foreign resources). Long-term capital is expensive for the company. Its average cost is characterized by the WACC value. Benefits of AMT investments realization in the form of benefits to the manufacturing cost savings and increased customer satisfaction should outweigh the negative cash flows and costs during the useful life of the investment including the cost of capital, which covers the investment.

Only in this case, the implementation of AMT investments can contribute to maximizing long-term corporate value. Improving the performance of the company and its value is observed in the “financial perspective” of the BSC concept. To express the values recommended by [33] and other authors to choose the EVA indicator that characterizes how the company has contributed through its activities to value creation for its owners. EVA is needed to be disaggregated to individual generators of the individual perspectives of BSC. Based on the causal relationship of the metrics representing strategic objectives up to the “top” metric that is EVA. Then we have an overview of the various stages of value creation.

*Overall assessment of performance of particular firm using concept EVA*

Primary target of the company should be long-term maximization of company value. According to the Damodaran (Applied Corporate Finance) [9] this maximization inheres in three areas:

- Investment decisions,
- Financial decisions and
- Dividend policy. [9]

On the figure no. 4 is been shown how easily can be those expectations converted to the EVA concept. The scheme is based on the common formula economic profit creation.

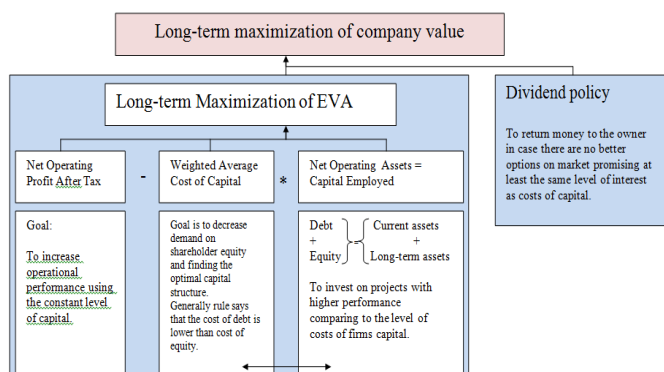


Fig. 4 Maximization of company value and EVA  
Source: [8]

Companies should face a problem if they use a significant amount of mutually conflicting indicators to express their targets. Strategic plans are often based on maximizing capital turnover and market share. The investment decision is made on the basis of net present value or internal rate of return. Managers are remunerated on the basis of sales or profits made. Products are evaluated on the basis of their profitability and their contribution to overall profit growth. Those contradictory objectives and indicators often result in inaccurate planning and decision-making. All of those problems can be solved with correct using, implementation and interpretation.

### C. Implementation of Continuous Monitoring of Market Needs and Demands / process 3

Options during the lifespan of an investment represent opportunities, not obligations. Opportunity (exercising an option) is used only if the market changes according to our expectations. That involves change in customer behaviour in expected direction (e.g. growth in demand for new products the company). The company must be immediately able to capture these changes and react.

### D. Options Exercising / process 4

Based on the identified changes in customer behaviour triggers firm an adequate action (response, opportunity, option). For instance, the expansion of production is happening according to the pre-prepared script, created on the basis of knowledge. The findings of serious deficiencies in the project at this stage are already unacceptable. The new layout of production, processes, testing, technology, everything has just as much as possible to fit in existing space and the possibility of the company. Technical issues should be feasible without serious intervention into current business processes and unnecessary additional costs.

We discussed and presented structure of used capital

budgeting methods in the Czech Republic. Usage of NPV, IRR and real options is very limited. We analysed and presented the barriers of broader real option penetration. To support better understanding and successful implementation of real options we presented model of real options implementation into the value creation processes of a model company using methodology of BSC as a framework.

The model for volatility calculation using Monte Carlo simulation principals is prepared but doesn't allow dealing with the correlation of certain parameters. That is currently the main focus of authors.

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