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GENERIC APPROACH IN CHOICE OF ADEQUATE METHODOLOGY FOR THE ASSESSMENT OF IT INVESTMENTS

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Abstract: *Investments into information technology (IT), (hereinafter: IT investments) have reached very high figures, which are still continually on the rise. IT potentials are being used in an increasing number of ways. Various company managers have different approaches to this issue. A large number of methods/models for the assessment of IT investments is available, so the question is posed of how to choose the adequate assessment category. The said reasons have initiated a need for defining the generic approach in the choice of adequate methodology for the assessment of IT investments, which was indeed the goal of this paper. General ideas to this approach stem from the fact that each IT investment has its purpose and belongs to a certain type of IT investment (decision-making aspect) which demands its relevant methodology for assessing IT investments. Two groups of demands (conditions) have been defined in choosing relevant methodology. The first group pertains to methodology analysis and determination of its compatibility with characteristics of the defined decision-making aspect. The second group of conditions pertains to methodology analysis with respect to its possibilities (abilities) of integrating quantity, quality and risk factors of IT decision. Conducted field research shows that the assessment of IT investments has been done mainly using simpler methods/models and their combinations, and is focused on quantity aspects of IT values.*

Key words: *IT investment, general ideas in IT investments assessment approach.*

1. INTRODUCTION

Assessment of the effectiveness of IT investments is an important process since IT investments have reached high and continually rising figures. IT potentials are being used in various ways. Therefore, management should know whether such investments are valid and result in the return of funds - and in profit. By assessing IT investments and the ways IT potentials are used, any organization can decide on further business improvements and possible benefits of new IT applications, or can change the structure of business investments in order to improve the use of IT potentials.

As stated, company management uses various approaches to this problem. A large number of methods/models for the assessment of IT investments are available, posing the question of how to choose the adequate assessment category. All these reasons point to the need for researching approaches and methodologies in IT investment decision-making

process, as well as defining general conditions for choosing the (most) adequate assessment category.

Chapter 2 gives a general review of the generic approach in choosing the adequate method/model for the assessment of IT investments. Each IT investment has its own purpose and belongs to a certain type of investment - which can be connected to one of the global aspects of business decision-making (*core, prestige, cornseed, must do*). In order to understand the purpose of IT investments, management must have a strategic plan of the development of (their) information system (IS), which stems from the model of business technology. Each decision-making aspect has its own characteristics and demands relevant methodology in order to facilitate IT decision-making. Therefore, before choosing the relevant methodology, we need to define the ***purpose of IT investments, recognize the structure of the decision-making problem and define the decision-making aspect***.

Two groups of demands (conditions) have been defined in choosing relevant methodology for assessing IT investments: (1) determination of its compatibility with characteristics of the defined decision-making aspect; (2) methodology analysis and determination of the possibility of its integration of quantity, quality and risk factors of IT decision making.

Chapter 3 gives more detail to individual concepts of generic approach to IT investment assessment: *the purpose of IT investments / decision-making aspects / conditions for the choice of relevant methodology*. In tune with the first group of conditions, an analysis was conducted of modern methodology for IT investment assessment (10 categories were chosen), and its characteristics and the means of the structuring of the decision-making problem were determined. Based on this analysis, the compatibility of the methodology with characteristics of particular decision-making aspects was also determined and thus a general road map for choosing the adequate assessment category was generated.

In view of the second group of conditions, we conducted an analysis of the same methodology and its possibilities (abilities) with respect to integration of important decision-making IT factors were determined (quantity, quality and risk factors).

Field research shows that the assessment of IT investments is a tough assignment and that it is usually conducted using simpler methods/models or their combinations and is focused on quantity benefits of IT investments. The reasons for this are numerous, but they generally tend to involve difficulty of assessing quality and risk factors of IT decision-making, and the current development level of methodologies used to assess such investments.

2. GENERIC APPROACH IN CHOOSING THE ADEQUATE METHODOLOGY FOR THE ASSESSMENT OF IT INVESTMENTS

Figure 1 shows the generic approach and general groups of conditions for choosing the adequate method/model for the assessment of (any) IT investment.

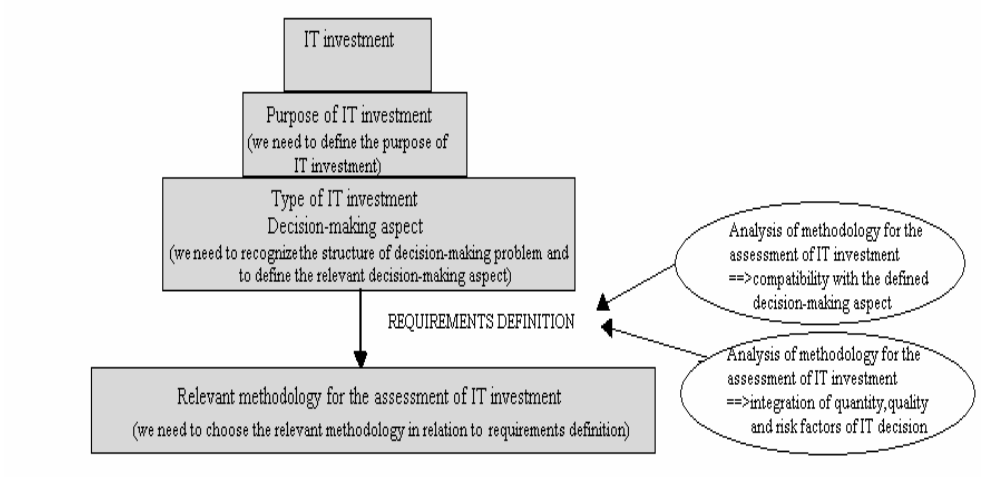

Fig. 1: Generic approach in choosing the adequate methodology for the assessment of IT investment

In choosing the adequate methodology for the assessment of (any) IT investment, it is important to first define the **purpose of IT investment.** After that, we need to recognize the **structure of the decision-making problem** (the goal, criteria, types). Quantity, quality and risk factors of IT investments are important criteria of IT decisions. In relation to the structure of decision-making problem, we need to define **the type of IT investment, i.e. the relevant decision-making aspect**. When defining individual decision-making aspects of IT investment, one needs to use the suggested matrix of business investments, as shown in Fig. 2 [7,p.43].

Risk \ Profitability	High	Low
High	Prestige High Risk High Profit	Cornseed Very High Risk High Profit
Low	Core Medium Risk Medium Profit	Must Do Low Risk Low Profit

Figure 2: Business investment types

According to the matrix, each decision-making aspect has particular characteristics, such as the clear or unclear structure of decision-making problems, expenses, risks, potential benefits, etc. This sets conditions on the **relevant methodology for the assessment of IT investment.** As stated before, the first group of conditions for choosing the adequate method/model of IT assessment demands we conduct the methodology analysis and determine its compatibility with the characteristics of the defined decision-making aspect. The second group of conditions calls for the methodology analysis and determination of the

possibility of its integration of (important) quantity, quality and risk factors of IT decision making. Field research shows that one assessment category by itself can hardly satisfy all these conditions. Therefore, the choice of adequate assessment category is usually based on the combination of several methods/models for the assessment of a certain type of IT investment.

3. IMPORTANCE OF INDIVIDUAL CONCEPTS OF GENERIC APPROACH TO THE ASSESSMENT OF IT INVESTMENTS

3.1. PURPOSE OF IT INVESTMENTS

In general, we recognize three global measures of IT business value, which, at the same time, represent purposes of IT investments➔ ***efficiency, effectiveness, advantages over competition.***

Efficiency*:** use of information technology to do same tasks faster, better, simpler, and in this way save resources. ***Effectiveness: use of information technology to do better work and in this way enable the achievement of better business results. ***Strategy*** (***competitive advantage):*** improvement of business by using IT potentials with the goal of strategic business changes and achieving advantages over competition.

Additionally, general fields of use for IT investments may be classified in four categories:

1. Efficiency and effectiveness of operative processes;
2. support for management and management efficiency;
3. redesign of business processes and modern organizational structure;
4. advantage over competition.

If IT is being used in order to substitute human work factor and automate tasks and operative business processes, the main benefit will probably be the increase of **system efficiency** (e.g. decrease of time needed for one cycle, staff decrease, less costs of printing and distribution of documents, etc.) **System effectiveness** focuses on the increase of product/service quality, timeliness and availability of data, better operative processes under industrial standards, distribution of information, transformation of information into desired goals, etc.

If IT investments should expedite new ways of management, benefits may be summed up as **management support.** Benefits include less time and more quality of decisions, better communications, standardization, quick reactions to changes in law, better control, increased flexibility, compatibility with consumer systems, higher efficiency in use of sales capacities.

Furthermore, if IT is implemented for **organizational use**, one can define mostly qualitative, difficult to measure results/effects: redesign of business processes, redesign of business network, development of modern organizational structures, changing the company's image, etc.

If IT is used in order to gain **advantages over competition**, the final goal is uneven competition. Benefits of IT use here encompass increased quality of operative margins with respect to the competition, increased market share, differentiation/diversity of new products and services, making of unique product characteristics, purchasing and selling power.

Investing the development of infrastructure also contains a purpose and belongs to the type/aspect of IT investment which demands relevant approaches to assessment. Just what is the flexible and beneficial/effective IT infrastructure and what is its cost/benefit ratio is a topic of growing number of researches. Chapter 3.3 shows the general empirical model

which defines the elements of flexible IT infrastructure and researches co-relations of flexible IT infrastructure with investment expenses and benefits which are a result of its use.

3.2. DECISION-MAKING ASPECTS OF (AND ON) IT INVESTMENTS

Should decisions on IT investments be made and treated differently than other business decisions? Under normal conditions, company will make an investment only if it believes it can make a profit on invested capital - which would further ensure a good position against the competition. Since this means the capital can be used for the same goal in various ways, deciding on IT investing would be the same as with any other business investment. Not being completely unique, IT decisions differ from all the other decisions partly because of IT characteristics, and partly by management position on the subject. Consider the following:

- IT means great risk and high prices, but is a tool of great achievements, and therefore can't be ignored;
- expenses involving IT will probably make up a big part of capital investments;
- strong rhythm in the field of IT technology disables managers to be well acquainted with all decision-making aspects;
- most organizations can not fall back on previous results or studies on cost assessment or benefits assessment.

3.2.1. Decision-Making on Investing into Core Business Projects (*CORE aspect*)

According to the business investments matrix (Fig. 2), we can see that **CORE** category is most often burdened with structured decision-making problems, mid-level of risk and effects of investments themselves.

In the context of this category of business investments, the reasons for the decision are mostly known (e.g. outdated machines, expensive maintenance, decreasing quality of materials, no new products, etc.) The problem is relatively easy to identify, and subsequently, so are the costs of solving the problem. Furthermore, consequences of non-investing, such as high maintenance costs, a lot of waste/scrap, high inventory, impossibility of production of new products/services, etc., is also possible to ascertain. Along with these characteristics, we should also list the elements of quality effects of investments, whose importance in today's business continually grows, but is not assessed adequately and not nearly to a wide enough extent. Quality elements are hard to estimate/assess objectively, since there are no standardized metrics for such measures, and, therefore, such assessment is left to systems of agreed-upon or substitution metrics, average or relative values, etc.

Risks in this category are not too high, although they do exist. Along with other risks, we especially single out those which pertain to reactions of employees to change. The difference between positive and negative reactions mainly depends on managers and the way they present the project to subordinates.

In short, this aspect of decision-making is characterized by the following:

- decision-making problems are, in most cases, well structured;
- decision maker is generally familiar with the decision-making problem(s);
- there are not many options posed as problem-solving decisions;
- expenses (costs), risks and potential benefits of investing can be ascertained;

- there are intangible benefits (not as great as in the level of strategy/prestige), but they are not adequately assessed;
- consequences of non-investing are also apparent; they are generally not assessed.

This aspect of decision-making globally goes with IT investments initiated for the purpose of **efficiency and effectiveness of business processes**. Based on this, IT projects can be categorized into two categories: IT projects whose goal is *"to automate a business"*, and IT projects whose goal is "*to informate a business*". In the second case, IT potentials are used in a way which produces new values through the business process, which is mainly represented by quality elements of IT benefits (new product, customer benefits, better decision-making, customer satisfaction, etc.). Managers lacking the vision of how to use such potentials and concerning themselves predominately with the technical side of IT development will generally put IT investments into business automation in order to save on resources (*efficiency of business processes*).

3.2.2. Decision-Making on Investing into Strategic Business Projects (*PRESTIGE aspect*)

Strategic (prestige) business investments are burdened with high risk, but can also lead to high profit based mainly on quality (intangible) benefits and are not very frequent in most organizations (Fig.2). It is difficult to ascertain financial amounts for specific problem-solving decisions. Suffice to say, the expenses run quite high.

In short, decision-making aspect is characterized by the following:

- decision-making problems are mostly unstructured;
- decision maker sometimes seeks expert help from certain fields, with the purpose of generating various decision options;
- large number of options;
- expenses (costs), risks and potential benefits are hard to ascertain;
- quality benefits are not assessed well enough and carefully enough, and mainly after system implementation;
- consequences/effects of non-investing are also unclear.

Generally, this aspect is coupled with IT investments initiated with the purpose of organizational changes, the redesign of business processes and the facilitation of modern organizational structure, as well as gaining advantages over competition. To gain such strategic/competitive advantages using IT means one must realize those activities within the organization which are different than those the competition has; such activities should produce new values and allow the organization in question to become the leader in its scope of business, whether by using unique characteristics of their products/services, special consumer benefits/advantages, by globalization of business or low business costs and expenses.

3.2.3. Decision-Making on Investing into Research and Development *(CORNSEED aspect)*

This kind of investment (so-called "*cornseed*") is also faced with high degrees of risk and expenses, but it, by all means, constitutes projects which ensure economical cost-effectiveness (i.e. profitability) and the future of organizations using them. In these cases, decision-making problems are mostly unstructured and large sums of money are being invested in a field which does not have easily recognizable positive results (Fig.2).

IT investments meant for research and development of IT infrastructure within organizations represent a special type of IT investment and can be categorized into the observed decision-making aspect (*CORNSEED*). Just what characterizes flexible and high quality IT infrastructure, how much it is valued as an asset and which benefits (quantity/quality) are gained via its use are important themes ever more present in a growing number of researches. Empirical model defining the main components of a flexible IT infrastructure is described in Chapter 3.3; this model examines the co-relations of defined components and investments into the development of such infrastructure, and co-relations with potential benefits which are gained by its use (*competitive advantage*).

3.2.4. Decision-Making on Essential Business Investments (*MUST DO aspect*)

Sometimes the organization must invest into something which does not result in tangible results, which often stems from applicable laws and the need for essential business changes (VAT, customs charges, employees, etc.), where the organization has no choice but to accept the new rules of the game. Such decisions often carry a low level of risk and benefits, informal level of assessment, and are continuous through business (Fig.2).

3.3. ANALYSIS OF THE METHODOLOGY FOR THE ASSESSMENT OF IT INVESTMENTS: COMPATIBILITY WITH THE DEFINED DECISION-MAKING ASPECTS

The previous chapter contained descriptions of individual IT investment decision-making aspects and their main characteristics (the level of structure/lack of structure of the problem of decision-making, potential benefits, risks, expenses, etc.). This chapter describes the characteristics of a modern methodology for the assessment of IT investments (**10 categories chosen**), analyzes its possibilities and the way the decision-making problem is structured and determines the compatibility of this methodology with individual decision-making aspects (Table 1).

Table 1: Comparative analysis of modern methodology for the assessment of IT investment: compatibility with defined decision-making aspects

Methods/ models	Characteristics of decision-making problem structuring and the assessment of IT investment	Compatibility with the decision-making aspect	Purpose of IT investment
Return On Investment (ROI)	The rate of ROI is defined as the profit or return divided by the investment required to help obtain the profit or return of a firm. ROI methods are supported by a number of formal capital investment appraisal techniques. There are three commonly used ROI methods, net present value (NPV), discounted cash flow (DCF), and payback period. NPV and DCF calculations base their discount rate on an interest rate regarded as appropriate by the financial managers of the organization, while payback period method does not require an assumption of fixed interest rates. Methods based on payback simply requires an IT project to repay its investment over a prescribed period. In general, all ROI methods require the estimation of cash flow rates. ROI methods do not include intangible benefits in the evaluation process. These methods favor using benefits which are directly attributable, often, but not necessarily, in the form of direct cost savings.	VITAL/CORE	Efficiency of business processes
Cost/Benefit Analysis (CBA)	This method is very handy for the assessment of the justification of IT investments based on the comparison of determined costs and benefits. The method is, by large, quantitative. Difficulties with the assessment of quality elements can be found on the input side (IT investments) as well as the output side (IT benefits/effects), since such factors should be quantified and expressed in financial terms (actual amounts). In that case the method requires the existence of a general agreement on measures used for pairing values with quality elements. For example, if one of the goals of IT implementation is the increase of customer satisfaction, benefits can be expressed in terms of savings through the lower number of returned products and less customer complaints. This approach attempts to solve two problems: (1) the difficulty of identifying benefits or expenses(costs) that show no visible market value or price, i.e. intangible, quality factors; (2) the difficulty of quantifying of such values.	VITAL/CORE	Efficiency of business processes
Cost/Benefit Analysis (CBA)	This method is very handy for the assessment of the justification of IT investments based on the comparison of determined costs and benefits. The method is, by large, quantitative. Difficulties with the assessment of quality elements can be found on the input side (IT investments) as well as the output side (IT benefits/effects), since such factors should be quantified and expressed in financial terms (actual amounts). In that case the method requires the existence of a general agreement on measures used for pairing values with quality elements. For example, if one of the goals of IT implementation is the increase of customer satisfaction, benefits can be expressed in terms of savings through the lower number of returned products and less customer complaints. This approach attempts to solve two problems: (1) the difficulty of identifying benefits or expenses(costs) that show no visible market value or price, i.e. intangible, quality factors; (2) the difficulty of quantifying of such values.	VITAL/CORE	Efficiency of business processes

Methods/ models	Characteristics of decision-making problem structuring and the assessment of IT investment	Compatibility with the decision-making aspect	Purpose of IT investment
Return On Management (ROM)	Strassmann [5, p. 188] insists that IT serves primarily as operative management aid. He defines the output of management as "added value" of management, which is the value which is left over after all direct operative costs are removed from the value added to direct work. Strassmann suggests an index of total management effect achieved by the implementation of IT. That index is achieved by dividing the value added to management with management costs. These methods are focused toward the quality aspects of efficiency. If the value added to management is larger than management costs, the effects and efforts of management are productive (value output is greater than value input).	VITAL/CORE	Efficiency of business processes
Information Economics (IE)	Information Economics is a variant of cost-benefit analysis, tailored to cope with the particular intangibles and uncertainties found in information systems projects. It retains ROI calculations for those benefits and costs which can be directly ascertained through a conventional cost-benefit process. However, the decision making process used in IE methodologies is based on a ranking and scoring technique of intangibles and risks factors associated with the IT investment. Here also, surrogate measures are often used for most intangible and risks factors which are hard to estimate.	VITAL/CORE	Efficiency of business processes
Value-Added Analysis (VA)	This analysis begins with the conclusion of most successful innovations being based on the increase of added value, and not on cost savings. Multi-phased, evolutionary process begins with the system prototype. The user is being asked to give the analytic personnel return information on values and limits of solutions reached using the prototype. Advantages of this method include: (1) quick identification of customer needs in order to ascertain values agreed upon for quality outputs; (2) improved communication between analytic personnel and users, which gives decision makers a certain degree of security on benefits being able to be realized using prototype demonstrations; (3) flexible assessments of benefits and costs, which allows the management to continue the assessment, or to stop at any moment; (4) evolutionary approach accommodating users.The method also has several disadvantages: (1) determining wanted substitutive values and the development of the prototype may be a drawn out and expensive process; (2) the method lacks the initial assessment of final benefits and costs, which leaves the management open to unexpected costs in the future.	CRITICAL/CORE	Effectiveness of business processes
Multi-objective, Multi-criteria (MOMC)	This method attempts to develop a general measure of utility where utility is defined as the satisfaction of an individual's preferences. The method is based on the belief that people's behavior is determined to some extent by their feeling that their preferences are recognized. Where there are many stakeholders, the best IT investment is that which will deliver the highest aggregate utility or which provides the highest overall measure of satisfied preferences. The MOMC method is probably best applied to complex projects which attempt to meet the needs of many different users and where the benefits are intangible. The MOMC method does not provide any data for ROI calculation.	STRATEGY (PRESTIGE)	- Business process improvement – Organization transformation – Competative advantage

Methods/ models	Characteristics of decision-making problem structuring and the assessment of IT investment	Compatibility with the decision-making aspect	Purpose of IT investment
Hybrid MOMC model	This model combines the Integer Goal Programming approach and the Analytic Hierarchy Process (AHP) approach. It is a structural decision model which allows decision makers to identify all tangible, intangible and risk factors involved in the IT investment situation. All these factors are organized in a hierarchical structure and quantified through the AHP.This model allows the decision maker to establish priority levels for objective criteria, and to assign weights to subjective criteria using AHP according to his estimates of their relative importance in investment decision. The criteria can be ranked into priority levels according to the decision maker's preference. The purpose of establishing priority levels and weights is to thoroughly incorporate the decision maker's preference in terms of goal targets and relative values for the benefits and risks associated with the IT investment. Results derived from the AHP are used as inputs to the Goal Programming Model and selection process.	STRATEGY (PRESTIGE)	- Business process improvement – Organization transformation – Competative advantage
Critical Success Factors (CSF)	This method is used to explore the potential value of information systems. The approach is based on the concept of the "success factors". It invites the analyst to explore with executives the factors, which are in their opinion, critical to the success of the business in particular, the factors that are important for the functions or activities for which the executives are responsible. Issues can be ranked by the executives into levels of importance. The implementation of methods based on CSF involves comprehensive interviews of key managers to obtain their views about business mission, objectives, and current problems. After the interviews, the managers' opinion are cross-tabulated, compared, and ranked. From a group discussion about the divergence of opinions an agreement about systems investment priorities is expected to emerge. The advantage of the method is that it provides a focus on the issues which are regarded as important by the respondents.	STRATEGY (PRESTIGE)	- Business process improvement - Organization transformation - Competative advantage
Strategic Analysis and Assessment (SA)	Strategic analysis and assessment (1=low influence systems; 10=high influence systems), a highly subjective and quality-oriented approach, is focused on marking, grading and ranking the primary IT systems for business strategy support. In that context, we recognize two main, generic strategies: the differentiation strategy and the low cost strategy. The differentiation strategy is aimed at creating a certain product or service which differs from the rest of the competition by unique design, special customer benefits, after-sale services and top quality i.e. added value. The low cost strategy focuses toward very low cost/expense structure which allows high returns and profit. This strategy raises efficiency on all organization levels, where IT and logistics of business processes have an important influence.	STRATEGY (PRESTIGE)	- Business process improvement - Organization transformation - Competative advantage
Empirical Model for Assessment of IT Infrastructure Flexibility [3,pp. 167-209]	First model that examines the metrics of flexible IT infrastructure and its co-relation with IT investment metrics and metrics (measures) of company advantages over competition. Decribed below the table*.	CORNSEED	Development and maintenance of IT infrastructure

*Empirical Model for Assessment of IT Infrastructure Flexibility

The model developed by T.A. Byrd and D.E. Turner in 2000 [3,pp.167-209] researches the metrics of flexible IT infrastructure and its co-relation with metrics (measures) of IT investments and of company advantages over competition. In general, we define flexibility as the degree of ability of the company to answer to changeable market needs, thereby ensuring a good position in relation to the competition.

IT infrastructure includes two similar, but varying components: 1) technical infrastructure and 2) human infrastructure. Technical infrastructure is by experts regarded as a group of divided, ″tangible″ IT assets which constitute the base for business applications. The platform technology (hardware and operative systems), networking and telecommunications, data and central software applications all make up ″tangible″ IT infrastructure assets.

Human infrastructure includes knowledge and possibilities which are sought in order to gain efficient allocation and connection of IT resources within the company. Human infrastructure contains knowledge, experience, abilities, engagements and values of IT staff, which ensures high level of IT products and services.

What are the metrics of flexible IT infrastructure? Table 2 [3,p.181] shows the metrics (measures) of technical IT infrastructure, and Table 3 [3,p.183] the metrics of human IT infrastructure.

Table 2: Technical IT Infrastructure

Measures for Technical IT Infrastructure	Description
IT Connectivity	- abilities of any technological component to be added to any other component in or out of any company's environment - company uses open systems of network connectivity - new locations quickly adapt to IT infrastructure - company has data protection and access to various protocols
IT Compatibility	- ability to disperse any kind of information through any technological component - data which company receives through electronic connections is easily interpreted - company offers various information types to end users - company ensures multi-interfaces for outside end users - software applications can be easily transported and used via multi-platform system - information is distributed through the company regardless of location - user interfaces ensure transparent access to all platforms and applications
Applications Functionality	-ability to add, change or remove modules of software applications - end users use object-oriented tools for the development of applications - data processing does not limit business operations
Data Transparency	- free return and data flow between authorized personnel in the company or between companies no matter the location - data collected in one part of the company is immediately accessible to anyone in the company - company data base can communicate via various protocols - IT company manages data in various formats and standards -company is easily adaptable to various data base management systems, their protocols and standards

Table 3: Human IT Infrastructure

Measures for Human IT Infrastructure	Description
IT Management	- ability to manage IT, aimed at consistent development, implementation and use of IT in the company - alignment of business and IT strategy and quality of IS development - assimilation of knowledge on new methodologies of IS development - implementation of the information security management system - IS revision - assessment of the business values of IT investments
Business Knowledge	- knowledge and ability of IT staff in understanding business processes and the need for implementation of IT/IS in their functioning - IT staff support for end users
Technical Knowledge	-knowledge and abilities of IT staff concerning the software development, types of data bases and the knowledge of operating systems - knowledge and abilities of IT staff concerning hardware maintenance -knowledge and abilities of IT staff concerning their work on decision-support systems and expert systems -knowledge and abilities of IT staff concerning network management and maintenance, and saving and distributing data
Project Management	-knowledge and abilities of IT staff concerning planning, organizing and leading projects, developing good relations with clients and customers, their feel for organizational culture and policies

Investing into the development of IT infrastructure and achieving its flexibility may be observed through investing into IT technologies (applications, data and technical investment levels) and investing into IT staff (education aimed at raising the level of knowledge and abilities).

Furthermore, flexible IT infrastructure has a positive effect on the advantage of the company over competition, which is measured by the following metrics:

- primary activity effectiveness (effects of IT use in obtaining added value through the value chain);
- support activity effectiveness (effects of IT use in managing human resources and management support in general);
- resource management functionality (effects of IT use in successful allocation, control, planning and other activities which concern resources);
- threat (effects of IT use in assessing users, suppliers, competition analysis, etc.).

In order to test legal validity of metrics (i.e. factors) of IT infrastructure flexibility, we actually need to test their co-relation with metrics of IT investing and metrics of advantage over competition. Table 4 gives results of t-tests between factors of IT infrastructure flexibility and IT investments [3,p.189]. 11 of 16 relations are statistically important, although some figures in those relations are low.

Table 4: T-Test Results of Factors of IT Infrastructure and IT Investment

Factors of Flexibility of IT Infrastructure	IT Investment in Technology	IT Investment in Human Skills
IT Connectivity	0.063	0.272(**)
Applications Functionality	0.162(**)	0.103(*)
IT Compatibility	0.034	0.034
Data Transparency	0.276(**)	0.073
IT Management	0.164(**)	0.560(**)
Business Knowledge	0.056	0.575(**)
Project Management	0.100(*)	0.463(**)
Technical Knowledge	0.157(**)	0.511(**)

(**) Significant at $p<0.01$; (*) Significant at $p<0.05$.

Table 5 presents results of t-tests between the factors of IT infrastructure flexibility and metrics of advantage over competition achieved through IT use [3,p.190]. Table 5 shows that the factors of IT infrastructure flexibility are significantly related in 21 of 32 possible pairs. Therefore, the factors are significantly tied to metrics of investments into IT and metrics of competitive advantage.

Table 5: T-Test Results for Factors of IT Infrastructure and Factors of Competitive Advantage Through IT Use

Chart legend:
A-Factors of Flexibility of IT Infrastructure
Competitive Advantage through IT use:
B-Support Activity Effectiveness
C-Primary Activity Effectiveness
D-Resource Management Functionality
E-Threat

A	B	C	D	E
IT Connectivity	0.036	0.350(**)	0.055	0.135(*)
Applications Functionality	0.134(*)	0.335(**)	0.278(**)	0.159(**)
IT Compatibility	0.060	0.104	0.223(**)	0.179(*)
Data Transparency	0.156(*)	0.369(**)	0.349(**)	0.247(**)
IT Management	0.135	0.417(**)	0.265(**)	0.045
Business Knowledge	0.014	0.493(**)	0.254(**)	0.099
Project Management	0.016	0.198(**)	0.231(**)	0.032
Technical Knowledge	0.055	0.465(**)	0.341(**)	0.293(**)

(**) Significant at $p<0.01$. (*) Significant at $p<0.05$.

Other important questions posed within this problem area concern expenses of investing into the development of flexible IT infrastructure and benefits gained by its use. These questions are: Are the expenses (costs) higher than profit? If there is profit, in how much time does it cover all the expenses (costs)? Are benefits ″tangible″ or ″intangible″? Do

benefits include "tangible" results like return on investment, increased market share and increased profit? Does flexible IT infrastructure simply become competitive expense for many industries?

3.3.1. Road Map for Choosing Relevant Methodology for Assessment of IT Investments

The previous chapter featured the compatibility analysis of chosen methodology for the assessment of IT investments, with individual decision-making aspects. Pursuant to said analysis, this chapter focuses on generating a general road map functioning as support for IT decision makers in choosing the (most) relevant method/model for the defined decision-making aspect (Fig. 3).

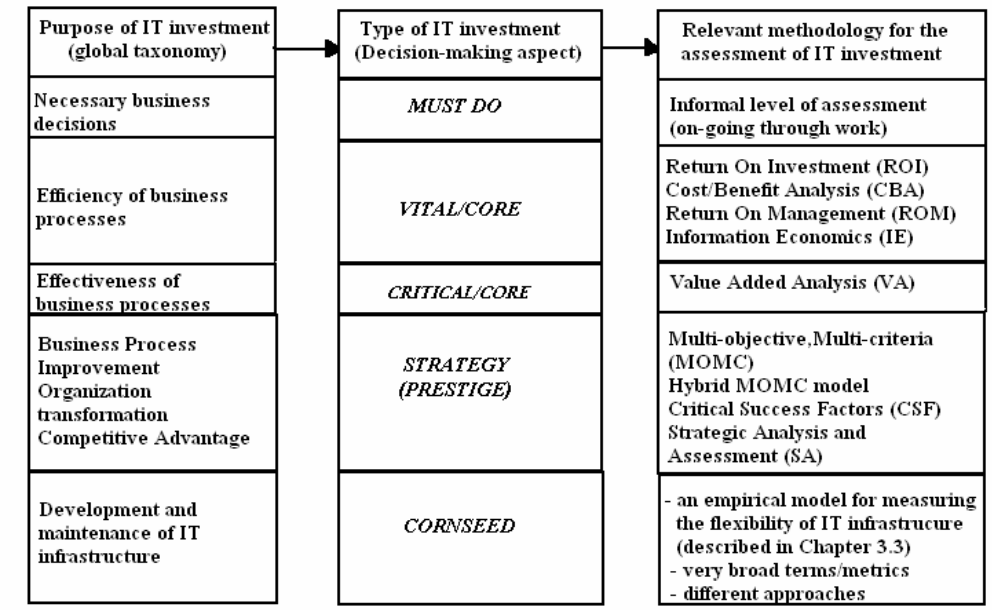

Figure 3: Road map for choosing the relevant methodology for the assessment of IT investments

3.4. ANALYSIS OF METHODOLOGY FOR ASSESSING IT INVESTMENTS: INTEGRATION OF QUANTITY, QUALITY AND RISK FACTORS OF IT DECISION

Besides the first group of conditions for choosing the right (most relevant) methodology for the assessment of IT investments, we must also consider the second condition group. In case of both groups, the starting point is a recognized structure of the decision-making problem and defined decision-making aspect. After it is determined which methodology is compatible for the defined decision-making aspect, we impose the second set of demands on the methodology ➔ the possibility of assessment and integration of quantity, quality and risk factors of IT decisions. A basic overview of this case is shown on Fig. 4. The process also suggests that decision makers should perform an assessment of intangible benefits and risks prior to tangible benefits.

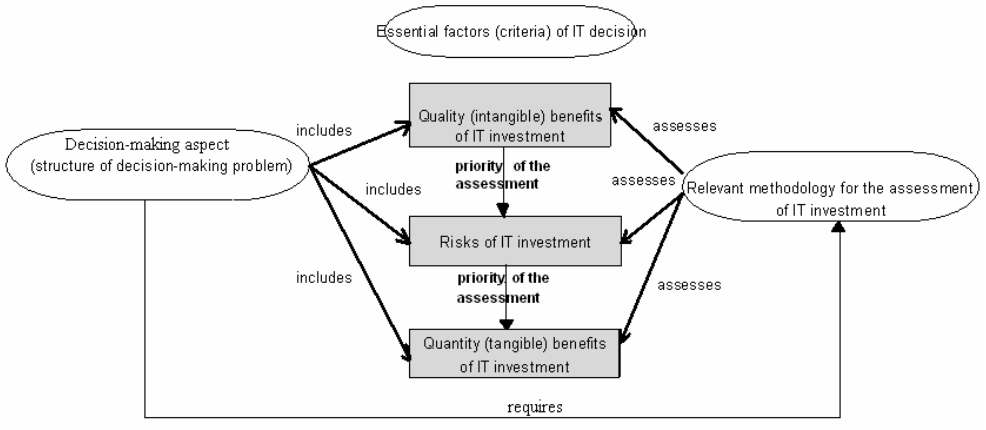

Figure 4: Integration of quantity, quality and risk factors in Assessing any type of IT investment

Actual practice shows that it is a lot tougher to assess benefits and risks of IT investments than expenses (costs) of such investments. Concerning IT benefits, there are several reasons for this assertion.

(a) Various types of benefits. Since we are talking about a great number of different types of effects/benefits, there are difficulties tied to understanding their characteristics, as well as means for their assessment. There are no standard metrics/measurements for the assessment of quality effects; a mixture of variant approaches are used instead, including substitute metrics, agreed-upon values and relative weights/values, which, of course, lessens the objectivity of any such assessment.

(b) Assessment of IT benefits is conducted as a part of the business process it supports.

(c) New technologies may have the ″postponed″ effect.

Short-term effect of IT use may result in proportionally higher benefits which are difficult to assess.

IT is, by its characteristics and the speed of development, a technology paired with various and relatively high risks. The following reasons for this pose themselves: first, IT components are relatively brittle in terms of component damages, hard disk failings and possibility of withstanding physical stress; second, information systems will probably be the target of disgruntled employees, protestors, even criminals; finally, the complexity of information systems and the application of distributed processing have increased difficulties of design, development, security and protection and, in fact, entire management of information systems. It could generally be said that structured IT projects carry a lot less risk than non-structured projects whose outputs are subjugated to subjective manager assessments, and are, therefore, susceptive to change.

Practical experience has shown that managers which are not prone to risk mainly look for short-term IT investment values, do not utilize IT potential in adequate manner and tend to ignore cumulative effects of IT use.

Integration of said factors is necessary for the assessment of any type of IT investment. Also, it is desirable that the category of assessment in its nature be as objective as possible (use of mathematical algorithms and terms in the development of calculations), since highly subjective and quality assessment processes diminish the actual result value.

The paper also contains an analysis of chosen methodology for the assessment of IT investments, aimed at determining its possibilities/abilities of integrating the main factors of IT decision (Table 6).

Table 6: Comparative analysis of modern methodology for the assessment of IT investments: integration and assessment of quantitative, qualitative and risk factors of IT decision

Evaluation (assessment) category	**Measures of IT benefit factors**	**Measures of IT risks**	**Major advantages**	**Major limitations**
Return On Investment(ROI)	tangible	discount rates, surrogate measures	mainly quantitative, focus on efficiency	no intangible factors, reliance on accounting data
Cost/Benefit Analysis(CBA)	tangible factors, surrogate measures for intangible costs or benefits	same as ROI	mainly quantitative, focus on effectiveness	some intangible factors and surrogate measures for intangible factors
Return On Management (ROM)	tangible, labor value-added as intangible	not addressed	mostly qualitative measures of efficiency	limited quantitative measures, assumptions hard to meet
Information Economics (IE)	tangible and some intangible	surrogate measures,risks with ranking and scoring	mostly quantitative; the method links the quantification and comparison approaches with qualification approaches	major simplifying assumptions and models
Value-Added Analysis(VA)	tangible, agreed values for intangible	not addressed	tangible factors	prototyping, several revisions needed in order to reach conclusive results
Multi-objective,Multi-criteria(MOMC)	tangible and intangible	several measures of utility and risks	mainly quantitative, multiple and conflicting objectives	relatively new, still in development
Hybrid MOMC model	tangible and intangible factors	direct risks, user's surrogate measures	tangible, intangible and risk factors; higher effectiveness	relatively new mathematical model
Critical Success Factors(CSF)	user's surrogate measures	user's surrogate measures	intangible factors, focus on effectiveness	highly qulitative process, subjective assessment
Strategic Analysis(SA)	tangible and intangible factors	surrogate measures for risks and costs	intangible factors, focus on effectiveness	highly subjective and qualitative process
An empirical model for measuring the flexibility of IT infrastructure	tangible and intangible factors	not addressed	The first model that constructs measures of IT infrastructure flexibility.	Simple model in need of development in order to assess quantitative and qualitative IT effects/benefits, as well as risk assessment and the assessment of other factors of investing into a flexible IT infrastructure.

In order to give some detail to this analysis, we used Table 7 to show a methodology especially focused on the assessment of IT investment risks.

Table 7: Methodology for the assessment of IT investment risks

Evaluation (assessment) category	Measures of IT benefit factors	Measures of IT risks	Major advantages	Major limitations
Real Option (RO)	tangible and intangible factors	surrogate measures for risks and costs	intangible factors, focus on effectiveness	highly subjective and qualitative process
Portfolio Approach (PA)	measures for cost savings	direct measures of risks	higher efficieny	mainly quantitative (financial models)
Delphi Approach (DA)	user's surrogate measures	user's surrogate measures	tangible, intangible and risk factors	highly subjective and qualitative process

By doing this analysis, we can conclude that most assessment categories (methods/models) are aimed at confirming cost-effectiveness of investing into IT. Their purpose is to estimate whether IT benefits, can overshadow its risks and expenses. **However, a small number of categories explicitly include qualitative and risk elements in their assessment process.** Qualitative IT benefits have a growing curve in the assessment of IT investments. If a particular company knows how to use IT potentials and does not use IT only in order to automate their business, such quality IT benefits can be gained through various organisational, sociological, economical and other aspects. Such benefits are very hard to pin down using standard metrics. To annul this problem, various methods and models of assessing such values have been in development (surrogate metrics, values and weights agreed upon, subjective assessment, etc.) The point being, the assessment of quantity (quantitative) and quality (qualitative) benefits should be conducted for all types of investments into IT. It is also important to assess the possible investment risks, in order to ensure that benefits outweigh the risks.

Concerning objectivity of methodologies for the assessment of IT investments, analysis results and field investigations show there is no such thing as a fully objective methodology (or, for that matter, a fully objective assessment category). For example, Table 7 shows there are assessment categories which include all needed factors (quantity, quality and risk factors), but they are highly qualitative and subjective in nature (categories RO, DA).

Furthermore, Table 6 shows that mathematical models, MOMC and hybrid MOMC, include both quality and quantity measurements of IT benefits, as well as IT investment risk assessment factors. Although these categories are mathematical models, they also rely on subjective views and estimations. Therefore, even in the more objectively oriented methods/models the calculations are mainly based on subjective criteria.

4. CONCLUSION

Since IT investments are high, getting continually higher and are full of risk, any wrong decision may carry negative effects for the organization. On the other hand, if the organization does not initiate advancements based on new IT investments that require adequate assessment of their effectiveness, this could have a negative bearing on the

company position among the competition. This leads us to the importance of the IT investment assessment process.

Today there are various approaches, methods, models and metrics for the assessment of IT investments. Company management seems to undermine the importance of this process. Therefore, the goal of this paper is to suggest a generic approach and describe general ideas in tackling the problem of assessing IT investments and choosing relevant methodologies. Before choosing the method/model for the assessment of any IT investment, one needs to define the purpose of that IT investment, recognize the structure of the decision-making problem and define the relevant decision-making aspect (*core, strategy, cornseed, must do*). The defined decision-making aspect then demands a relevant methodology. Two groups of conditions have been defined for choosing the adequate assessment category.

The first group of conditions concerns methodology analysis with respect to its characteristics and the way the decision-making problem and assessment of IT investments in general are structured. This allows us to determine the compatibility of the methodology with the defined decision-making aspect and the purpose of IT investment. Pursuant to this, the paper contains an analysis of modern methodology for the assessment of IT investment (10 categories chosen) and the determination of its compatibility with individual decision-making aspects. Finally, this resulted in a general road map for the choice of one relevant assessment category which would serve as support for IT decision makers.

The second group of conditions relates to the analysis of the methodology for the assessment of IT investments with respect to its possibilities (abilities) of integrating quantity, quality and risk factors of IT decision. In the paper, such analysis was conducted on the previously chosen methodology (10 chosen categories), and further expanded by analysing risk assessment methods/models. The results of this analysis point to quantity aspects of IT values as the main orientation of most methods/models used in assessing IT investments. As far as methodology objectivity is concerned, calculations are often based on subjective assessments, leading us to believe there in no such thing as fully objective methodology.

Field research shows that the assessment of IT investments and the choice of (the most) relevant methodology for assessing such investments is a very difficult task indeed. The reasons for this most often concern: (1) difficulties in recognizing and defining quality elements of IT benefits, as well as risks of IT investing and structuring the decision-making problem; (2) the current level of the development of IT investment assessment methodology, which has so far not been satisfactory. In relation to that, it is difficult to perform in practice the ideas proposed in the approach to IT investment assessment (Fig. 1). Assessment of IT investments is being performed using simple methods/models and their combinations, and, most importantly, tends to focus on quantity factors of IT decision-making.

Of great importance for the whole problem area of assessment and decision-making concerning IT investments is the cooperation and joint functioning of business and IT managers, or IT experts. In practice, managers often forward responsibilities and decisions tied to IT business issues to lower level managers (IT management, heads of IT projects or other IT experts). Top managers of many organizations do not develop enough IT knowledge, do not see the importance of strategic IT development plan for their organization and do not perceive the importance of the assessment of IT business value. By the same token, IT managers do not develop enough business technology knowledge and knowledge on processes which need IT/IS implementation.

The suggested approach and conducted analyses help decision-makers in their choice of adequate methodology for the assessment of IT investments, but also point to further need for additional research into the development of new methodologies and perfecting the existing ones.

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