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ANALYSING ECONOMIC VALUE CREATION IN TERMS OF THE INFOCOMMUNICATIONS INVESTMENTS OF DOMESTIC ENTERPRISES

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1. PRELIMINARIES AND OBJECTIVES

1.1. Preliminaries

Astonishingly high amounts of money are spent on ICT investments in the global economy. It has also been so during the current period of recession, even in 2008, its probably most difficult year. According to the calculations of the Gartner Group (The Economist, 25 October 2008, p. 11) end-users globally spent in excess of 3 trillion dollars on infocommunications investments (Information and Communications Technology – ICT). In the same year, in combination, domestic information and telecommunications markets amounted to as much as HUF 1,476 bn (in Mozsik 2008, 14 – IDC data).
As a teacher of Business Information Sciences at the Faculty of Economic Science of the Budapest Business School in Zalaegerszeg, the problem that in terms of economic utility we can provide really little definitive information about these perceivably huge volume investments of great importance began to intrigue me more and more.

1.2. Objectives

The objective of the PhD dissertation was to develop a really practical economic valuation technique to be applied for ICT investments. This method should be suitable for enterprises to be used as a decision support technique in decision making situations with several investment alternatives, relying on sound foundations in economics, decision theory and information sciences. It should furthermore help enterprises in offering acceptable estimations of the economic utility of their already operative ICT systems.

I devoted my work to domestic enterprises. The majority of these enterprises belong to the category of small and medium-sized enterprises (SMEs) defined in accordance with Hungarian Act XXXIV of 2004 on Small and Medium-sized Enterprises and subsidizing SME development satisfying the legal harmonisation requirements of the European Union.

1.3. Hypotheses

With respect to the valuation methodologies published so far regarding ICT systems I tested the following hypothesis:

Hypothesis H1:

Both domestically and internationally, of the numerous complex techniques to evaluate ICT investments one can hardly find a scientifically well-founded and still simple technique that is available for domestic SMEs to actually measure the economic utility of their ICT systems or could specifically be recommended as a stand-alone application.

I tested the following hypothesis when identifying the valuation criteria of ICT systems:

Hypothesis H2:

There exists a set of criteria in the thinking of domestic enterprises that can provide a surveyable and relevant basis for the complex and multicriteria analysis of ICT systems. Companies are furthermore aware of the ever important cost, benefit and risk factors of information technology.

I defined the following hypothesis when researching whether the sets of valuation criteria of ICT systems can be arranged hierarchically:

Hypothesis H3:

Relying on due secondary and primary research, the hierarchical structure set of criteria present in the thinking of domestic enterprises can be constructed, which provides a relevant basis for the complex and multicriteria valuation of ICT systems in terms of decision theory.

When analysing the differing weights of the criteria of judging whether ICT systems are good for companies, I tried to offer an answer to the following hypothesis:

H4 hypothesis:

It is perceivable that domestic enterprises assign different weights to different features of the ICT systems. The preference relations between the differing importances of valuation criteria can be identified and therefore it becomes possible to draw up map of preferences map that can be recommended for the general use of domestic SMEs.

In terms of the comparing different alternatives I tried to see whether the following statement holds true for investment decisions:

H5 hypothesis:

A methodology can be developed with the help of which the preliminary complex comparison of ICT investment alternatives can be performed with due theoretical background and yet with practical utility.

When analysing the economic value creation of ICT systems I had to decide whether the following statement was true.

Hypothesis H6:

Based on the technical know-how described in literature and the wealth of knowledge available at enterprises a procedure can be developed by which the economic value creation of ICT systems can be measured adequately and practically during their subsequent operation.

2. MATERIAL AND METHODS

I applied the classic techniques of secondary research and relied on domestic and international publications as well as university, college, library and Internet sources.

In my case, the required primary research had to be exploratory since it was meant to clarify the fundamental domestic assumptions of the topic (Babbie 2008). To this end, I had to use two primary research techniques, in-depth interviews and questionnaire surveys (Malhotra 2001).

2.1. Secondary research

I processed all the domestic and international publications related to my topic that I could access. I reviewed the investment analysis methodology of economics, mathematical decision theory and ICT know-how available with respect to ICT systems. I furthermore processed the related methodologies and recommendations of world-leading business consulting and ICT companies.

2.2. Research by in-depth interviews

Planning the research by in-depth interviews

In the scope of in-depth interviews I had to identify the testing and valuation criteria required to define the value of ICT investments in accordance with Bőgel-Forgács (2003) and Temesi (2002, 18-19).

I planned the implementation of the in-depth interview in advance, in the form of an interview outline. I planned for the interview to take half an hour as suggested by (Malhotra 2001, 212).

The procedure of in-depth interview research:

Being a 'nonprobability sampling', the relevant sources must be identified for in-depth interviews (Babbie 2008, 205). Snowball sampling was the practical methodology for in-depth interviews (Malhotra 2001, 410). Here no database was available so I started out with a randomly selected group of companies 'known' to me and thought to be relevant for the test objective and I gradually got to numerous parts of the country. I recorded the whole of the in-depth interviews in voice files by a dictaphone and stored the same on the computer for subsequent analyses.

Valuation of in-depth interview research:

Valuation was based on listening to the recorded interviews, checking my notes taken during the interviews as well as the subsequent notes taken immediately after the interview. Processing the interviews meant that the key expressions got integrated and coded. I entered these data in a spreadsheet for analysis. I prepared diagrams based on the analysis worksheets.

2.3. Questionnaire survey

Planning the questionnaire survey:

I relied on the modernest survey method, the one relying on the Internet (Malhotra 2001, 245). The *tested population* (target population), in consideration of the recommendations of Babbie (2008, 279) and Malhotra (2001, 402), were the enterprises that had been awarded support in the scope of ICT investment tender no. GVOP-2005. 4.1.1. announced by the Hungarian Na-

tional Development Office (NFH). According to the NFH database there were 335 such enterprises. Taking the average expected response rate of 30% in consideration and that I would like to work with at least 100 completed questionnaires, I decided in favour of a full-scale census. 'The *population element* is the unit about or from which we seek information' (Malhotra 2001, 402). In my case it was inevitably the winning enterprises.

Planning the questionnaire:

The main principles along which the questionnaire was complied were the following ones for each chapter:

Chapter I: General recognition of the utility of ICT

Chapter II: The recognition of the economic value creation of ICT

Chapter III: The cost, benefit and risk factors of ICT

Chapter IV: Decision criteria when choosing from various ICT systems

Chapter V: Relevant background variables

Choosing the persons to question:

The first task was to select the *person to question* within each enterprise. After careful consideration, and bearing in mind the economic nature of my dissertation, I decided to address the economic managers of enterprises with the questionnaire.

2.4. Modelling

Modelling was based on the findings of the secondary research, economics, decision theory, statistics, information science and the findings of the in-depth interviews and questionnaire surveys.

3. RESULTS

3.1. The findings of secondary research

Having summarised my results I concluded that although the techniques available are definitely highly respectable, their implementation requires significant financial, statistical and ICT knowledge. Considering the current environment of and opportunities open to domestic enterprises, I hardly believe that we could say that the implementation of such resource-intensive techniques would bring due profits. This is more an opportunity for larger enterprises that can afford to hire expensive consulting companies.

Therefore, based on all the experience gained by studying technical literature, I consider hypothesis H1 verified.

Obviously, I intended to build certain elements of various techniques in my subsequent work, such are

- the discounted indicator system of investment analysis (NPV, IRR, PI, PB),
- the chart of accounts in Gartner's TCO (Total Cost of Ownership) to monitor the costs of ICT investments,
- TCA (Total Cost of Acquisition) of ICT investment costs structure of the Microsoft REJ (Rapid Economic Justification) methodology.

3.2. The findings of in-depth interviews

During my work, I tried to cover the largest scale possible in terms of geographic location, corporate size and business profile too. Finally, I managed

to conduct 18 in-depth interviews by exploiting the opportunities available to me to a maximum extent.

The geographical distribution of my in-depth interview is illustrated by Table 1.

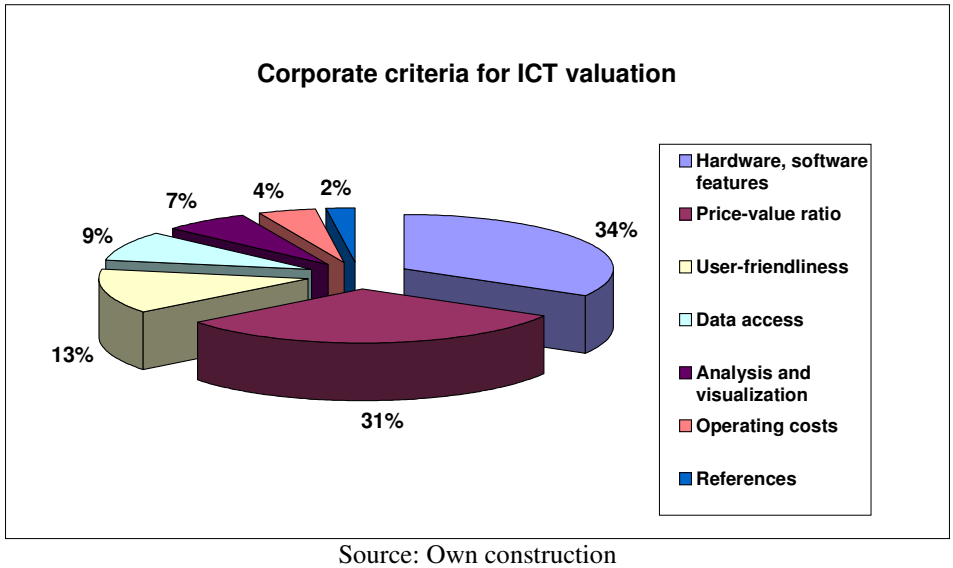
Table 1 The geographical distribution of in-depth interviews

Counties	EU – regions	In-depth interviews, pcs
Bács-Kiskun	Southern Great Plain	
Békés		
Csongrád		**4**
Pest	**Central Hungary**	**6**
Baranya	Southern Transdanubia	
Somogy		**1**
Tolna		
Győr-Moson-Sopron	Western Transdanubia	
Vas		
Zala		**7**
Total:		**18**

Source: Own construction

Figure 1 below shows the criteria that enterprises consider important when evaluating ICT systems. I included the most frequently mentioned criterion first and the others in a decreasing order of frequency in the diagram.

Figure 1 The valuation criteria of business ICT systems



Source: Own construction

The diagram suggests that hardware and software features and systems performance are the most important criteria for enterprises. They are immediately followed by the price factor and then by criteria related to usability and operation.

I also evaluated the opinions of enterprises with respect to the cost, benefit and risk factors of ICT systems in my dissertation in a similar way. In summary we can state that with the help of the in-depth interviews I was able to identify the most crucial valuation criteria of ICT systems.

Considering the above-mentioned I accept hypothesis H2 as verified.

3.3. The findings of the questionnaire survey

After one introductory round and five rounds to request replies and attract attention, I had 118 completed questionnaires in the spring of 2010. The most important findings of the survey were generated from pairwise comparisons since I could assign weights to the different ICT valuation criteria based on the aggregate matrices of these comparisons.

Table 2 shows the results of pairwise comparisons done as required by mathematical decision theory. I defined the aggregate opinions of decision-makers according to Rapcsák (2006) as the only correct solution by defining the arithmetical mean in a spreadsheet. These are perhaps the most important results of the questionnaires and are necessary for associating weights with the valuation criteria.

Table 2 The results of pairwise comparisons

QUESTION 15: The comparison of criteria			
	1	1-2	1-3
1: Customer-related	1	1.08	2.01
2: Financial		1	1.38
3: IT-related			1

QUESTION 16: The comparison of customer criteria

	1	1-2
1: Management service	1	1.11
2: Operator service		1

QUESTION 17: The comparison of the subcriteria of management service

	1	1-2	1-3
1: Data provision	1	1.09	2.04
2: Decision support		1	1.84
3: Visualisation			1

QUESTION 18: The comparison of the subcriteria of operator service

	1	1-2	1-3
1: Operative performance	1	1.23	2.23
2: Communicative performance		1	1.24
3: Helpdesk			1

QUESTION 19: The comparison of the financial valuation criteria

	1	1-2
1: Investment benefit	1	1.06
2: Supplier stability		1

QUESTION 20: The comparison of the subcriteria of supplier stability

	1	1-2
1: Business stability	1	1.44
2: References		1

QUESTION 21: The comparison of the subcriteria of IT-related criteria

	1	1-2
1: Software performance	1	1.58
2: Hardware-intensity		1

QUESTION 22: The comparison of the subcriteria of software performance

	1	1-2
1: Base module complexity	1	1.66
2: Complementary module complexity		1

QUESTION 23: The comparison of the subcriteria of economic investment value

	1	1-2	1-3	1-4
1: NPV	1	1.33	1.16	1.02
2: IRR		1	0.82	0.95
3: PI			1	1.11
4: PB				1

Source: Own construction

3.4. The methodology of selecting ICT investments

3.4.1. A multicriteria decision model

My task involved finding a solution for selecting ICT investment alternatives by following a general decision theory methodology.
In the case of multicriteria decisions, models are created in three steps:

1. the hierarchical structure of the set of criteria is to be constructed;
2. the weights to be assigned to the various criteria are to be defined; and
3. utility functions are to be developed to score terminal criteria.

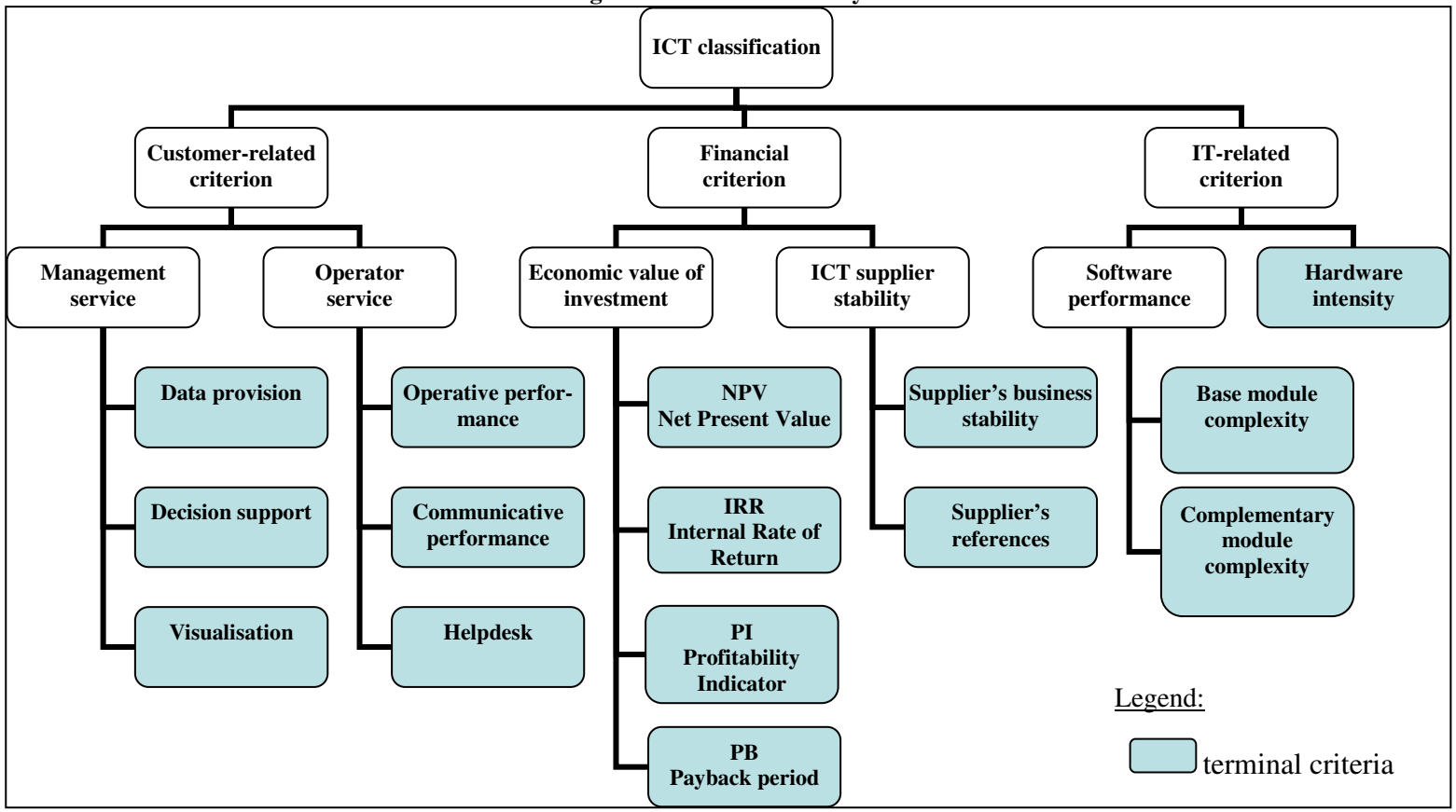
3.4.1.1. Constructing the ICT criteria hierarchy

Figure 2 illustrates the ICT criteria hierarchy I constructed.
I developed the criteria hierarchy for ICT as follows,

- the findings of the in-depth interviews and questionnaire survey were fundamental criteria,
- I relied on my 15 years' of former experience gained as a middle-level company manager,
- I integrated my 10 years' experience gathered as a teacher of economic information sciences,
- I also relied on the relevant educational materials of peer tertiary educational institutions,
- I studied the system of ICT requirements defined in tender announcements GVOP-2005-4.1.1, GOP-2009-2.1.1, KMOP-2009-1.2.5. and GOP-2009-2.2.3.

Based on all these, I consider hypothesis H3 verified.

Figure 2 The ICT hierarchy



Source: Own construction

3.4.1.2. Assigning ICT weights

I assigned specific weights based on the values stated in Table 2 by applying Saaty's APH technique (Temesi 2002). The essence of the technique is that weights are derived from the components of the right-hand side eigenvector belonging to the highest eigenvalue of the comparison matrix. I used the Expert Choice software for the specific calculation and the result is shown in Table 3.

Table 3 Weights

Description of valuation criteria		Weight
Criteria		
	Customer-related criterion	0.419
	Financial criterion	0.351
	IT-related criterion	0.23
Subcriteria		
	Management service	0.526
	Operator service	0.474
	Economic value of investment	0.515
	ICT supplier stability	0.485
	Software performance	0.612
	Hardware intensity	0.388
Terminal criterion		
	Data provision	0.416
	Decision support	0.379
	Visualisation	0.205
	Operative performance	0.449
	Communicative performance	0.322
	Helpdesk	0.229
	Net present value	0,279
	Internal rate of return	0.218
	Profitability indicator	0.259
	Payback period	0.244
	Supplier's business stability	0.59
	Supplier's references	0.41
	Software base module complexity	0.624
	Software complementary module complexity	0.376

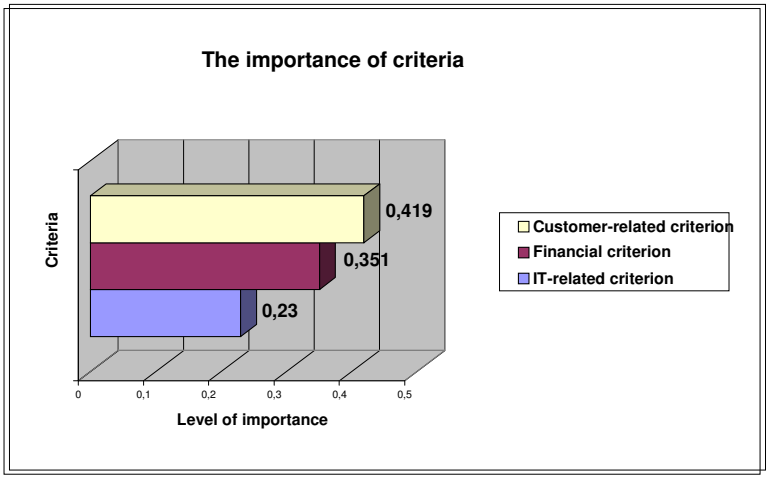
Source: Own construction

Evaluating the assigned weights

By interpreting the weights assigned we arrive at the wealth of knowledge that comprises the collective wisdom of 118 enterprises involved in and responding to the questionnaire survey.

The *highest level* of the hierarchy is always the goal. Level two is the level where I identified three different criteria, see Figure 3.

Figure 3 The importance of criteria



Source: Own construction

The figure indicates how highly enterprises rank the financial criterion, they however appreciate the customer-related criterion even more however little more it is. Therefore, the most important criterion for selecting an ERP system is that it would adequately serve the company, the managers and the operators alike. In my dissertation I performed the analysis for all levels.

As a result of the primary questionnaire research we consequently derived various weights to associate with ICT valuation criteria. This accumulated wealth of knowledge can be recommended to future decision-makers by allowing them to freely alter the weights if their opinions differ.

In consideration of the above-mentioned, I consider hypothesis H4 as verified.

3.4.1.3. Developing ICT utility functions

This determinant assignment of my dissertation can be found in a Microsoft Excel based spreadsheet programmed in Visual Basic containing macros and enclosed with my dissertation on a separate CD-ROM so its operative performance can be tested. The file's name is „*ICT minősítő modell_Academic.xls*".

I performed my work in observance of the following general principles:

- First of all, I collected the ICT performance characteristics for each terminal criterion (ranking criteria) based on which, when satisfied, the tested terminal criterion of the ICT alternative considered may get 1 functional point. If the criterion remains unsatisfied, no points are awarded. The sum of the functional scores of these equivalent characteristics (each is worth one point) shall be the independent variable, (x_i) of the utility function of the tested terminal criterion, $y_i = f(x_i)$. As a one-man decision-maker, in possession of the accumulated information described under the previous point, I tried to make statements related to the ranking criteria that, in my opinion, are little contestable in the field of ICT.
- Then, as a one-man decision-maker I defined the preferred y_i values of the one-dimensional valuation function of the tested terminal criterion on a scale of 0-100; these values were 0, 25, 50, 75 or 100 for each terminal criterion. Following this, I defined functional scores x_i belonging to these y_i utility values for each terminal criterion by the *midpoint method* (a dichotomic technique described by Temesi (2002, 63-66)), which defined the one-dimensional valuation functions making up the multidimensional valuation function in a normalised way.

- I drew up a chart of the x_i independent variable functional scores assigned by the decision-maker's judgment to utility scores y_i = 0, 25, 50, 75, 100 as dependent variables.
- Based on the graphical trend of the decision-maker's midpoint values I selected regression type functions for each terminal criterion and defined the respective regression equations.
- Based on the regression equation I calculated the regression values that define the utility score (y_i) of the given terminal criterion as a function of the sum of the functional (ranking) scores (x_i).
- Then I drew up a chart to illustrate how well the regression function (utility function) fits the decision-maker's original values.
- Finally I performed a regression analysis to verify the goodness of the fit of the regression function.

In the event all tests had positive results, I allowed for the regression function to be used as utility function, and therefore as the utility scoring technique based on the total functional score of the given terminal criterion.

In the following section I am describing the work performed and the decisions taken for each terminal criterion, which are included in detail by the '*Academic'* file enclosed with the dissertation.

With respect to the three terminal criteria under the management service subcriterion (Figures 4-5):

- Managers shall be ensured basic-level ICT services with the help of which they can check their specific fields simply and quickly.
- Overcomplicated management modules are no longer an asset; managers have no time to juggle with their computers.

– Consequently, the related utility scores slowly increase up to the middle of the chart, they leap up at the middle since a generally good service level is already fully acceptable here and further on the satisfied criteria have lower and lower values (a sigmoid logistic utility function).

Figure 4 The analysis of decision-makers' judgement – management service

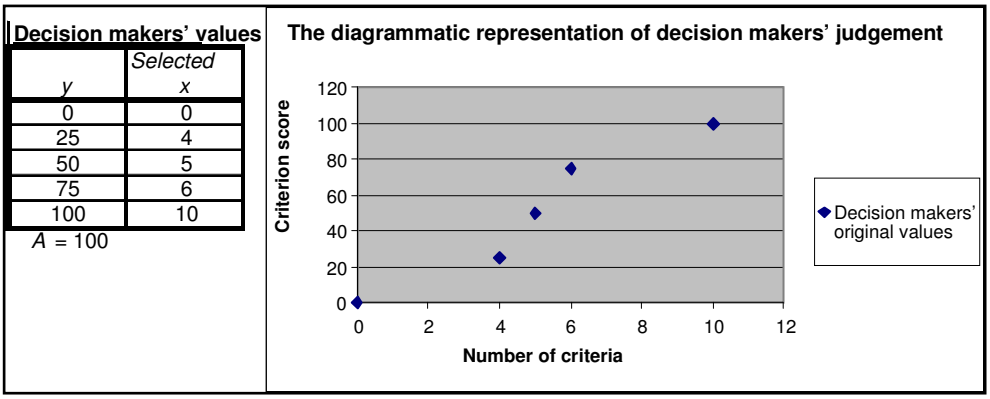


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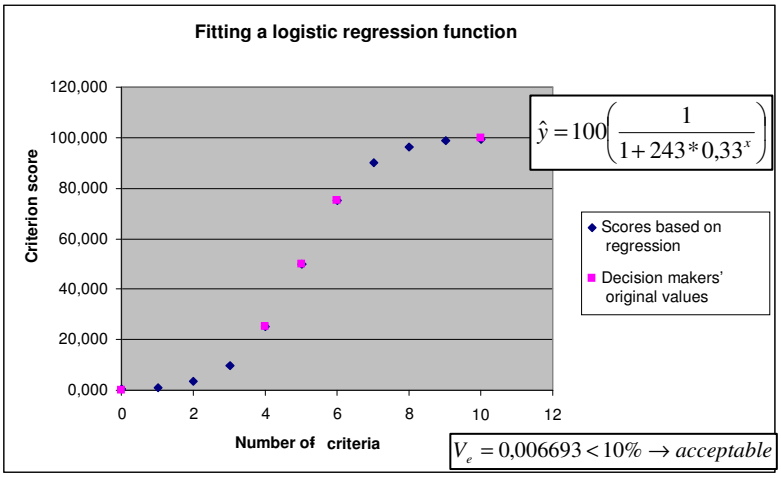
Figure 5 Fitting an autocatalytic (logistic) utility function



Source: Own construction

With respect to the three terminal criteria under customer service (Figures 6-7):

- For users it is very important for the ICT system to know everything since they work with various detailed sections of the software.
- Therefore, utility scores slowly increase all the way and at the end, in the know-all zone, they rise ever intensively (exponential utility function).

Figure 6 The analysis of decision-makers' judgement – customer service

Decision-makers' values

y	*x*
0	0
25	6
50	8
75	9
100	10

The diagrammatic representation of decision-makers' judgement

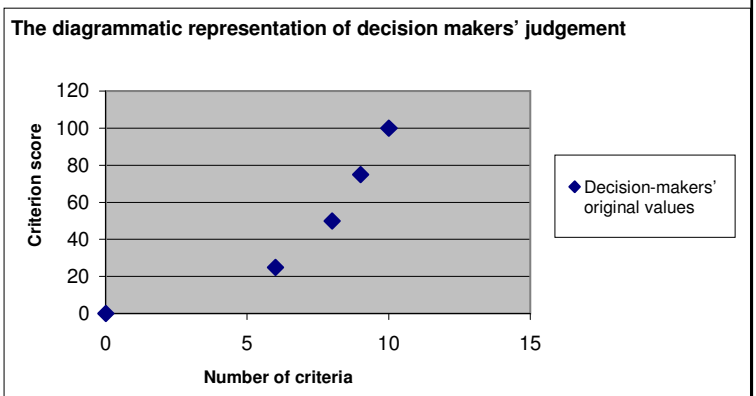


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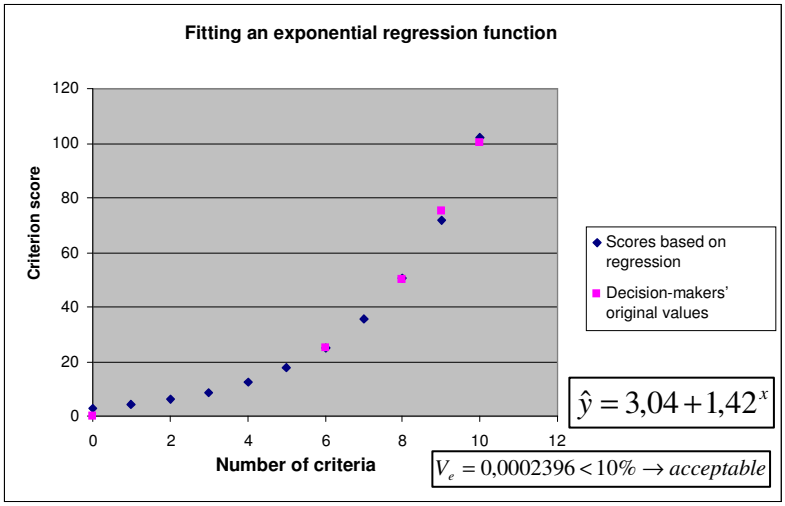
Figure 7 Fitting an exponential utility function



Source: Own construction

Discounted financial performance indicators (NPV, IRR, PI, PB)

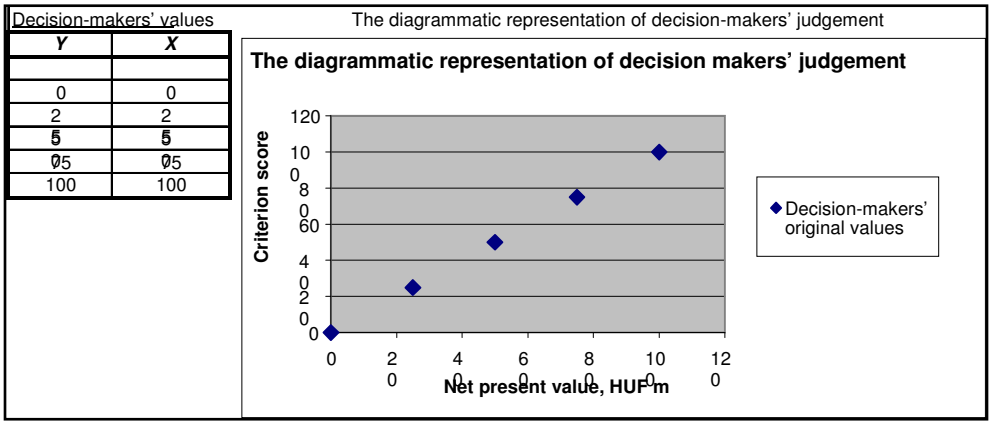
- Figures 8-9:

- The better the indicators, the more utility scores can be allocated, therefore the utility function is linear.
- Because of the different filtering conditions, they do not always start out from the origin, and they may furthermore have positive or negative gradients. These can be seen in the CD-ROM enclosed, while I am describing the topic of NPV in the following part.

Figure 8 The analysis of decision-makers' judgement – financial indicators

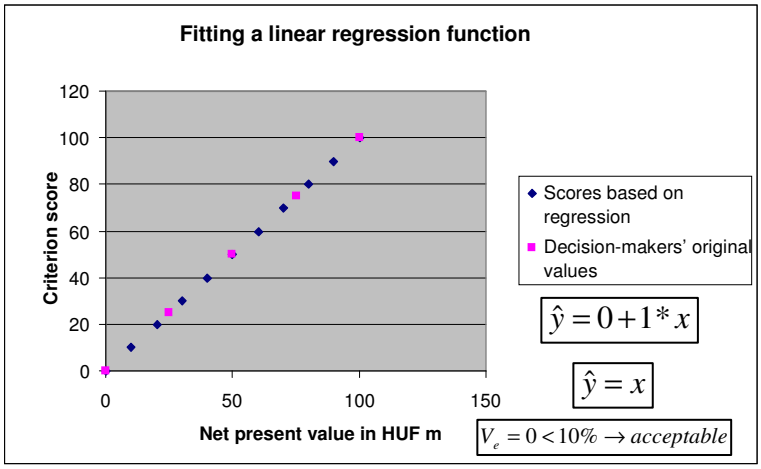
Decision-makers' values

Y	X
0	0
2	2
5	5
75	75
100	100



Source: Own construction

Figure 9 Fitting a linear utility function



Source: Own construction

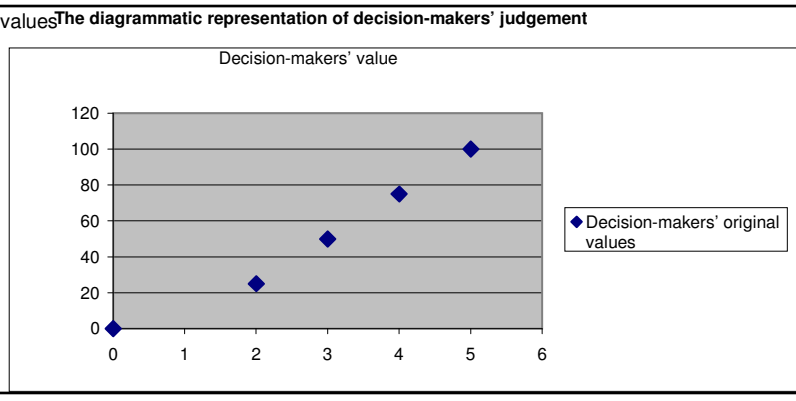
With respect to the two terminal criteria under ICT supplier stability (Figures 10-11):

- The utility scores rise intensively as the criteria are satisfied, at a rate between linear and exponential basic trends, so the utility function is a (multiplicative) power function.

Figure 10 The analysis of decision-makers' judgement – ICT supplier stability

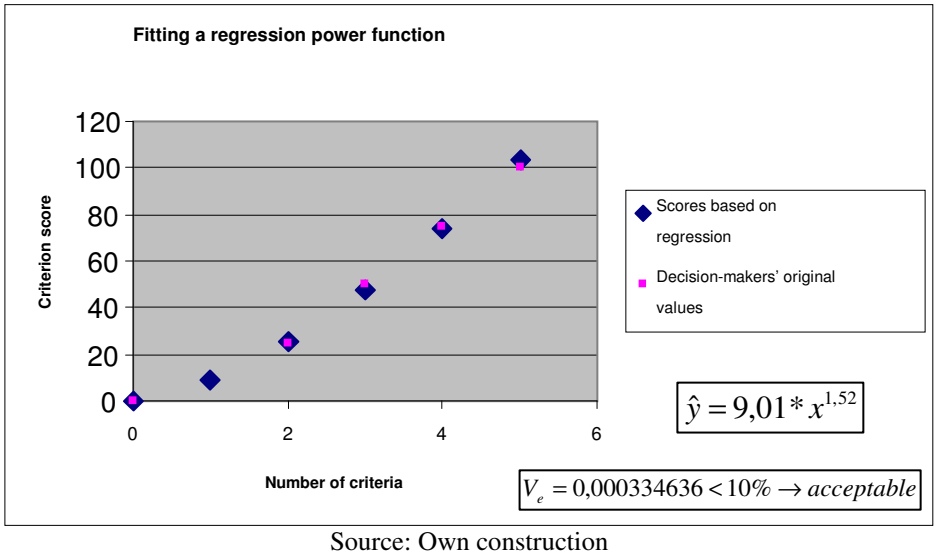
Decision-makers' values

Y	X
0	0
25	2
50	3
75	4
100	5



Source: Own construction

Figure 11 Fitting a power utility function



Source: Own construction

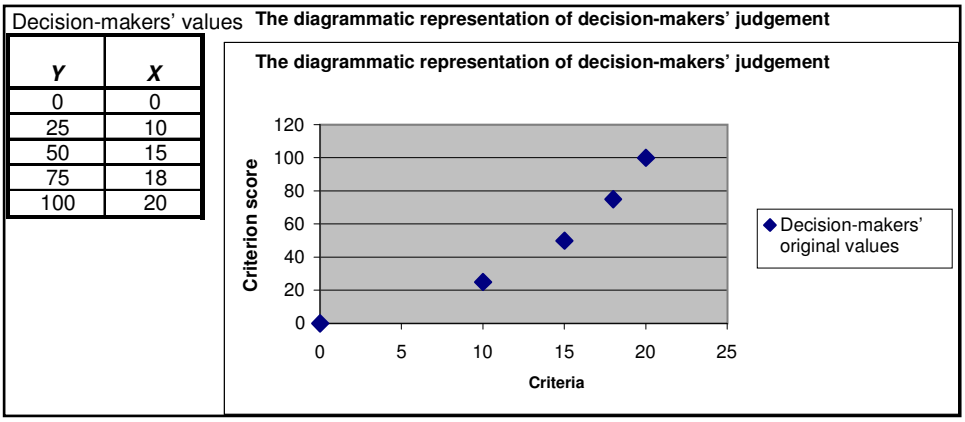
Software performance (with respect to the base module complexity terminal criterion), Figures 12-13:

- I applied a quadratic function also in order to offer a solution for all types of utility functions.

Figure 12 The analysis of decision-makers' judgement –ICT base module complexity

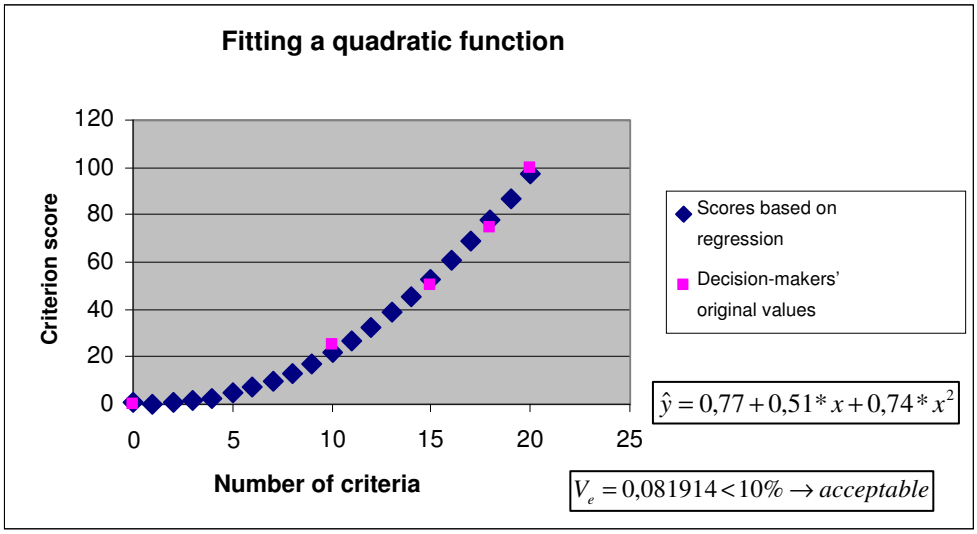
Decision-makers' values

Y	X
0	0
25	10
50	15
75	18
100	20



Source: Own construction

Figure 13 Fitting a quadratic utility function



Source: Own construction

Software performance (with respect to the complementary module complexity terminal criterion):

- The more complementary modules the ICT system is equipped with, the more utility scores can be allocated, and therefore the utility function is linear.

ICT criterion (with respect to the hardware intensity terminal criterion):

- Having studied the ICT requirements set forth in tenders announced with EU co-financing, I prepared an evaluation worksheet with the help of which I defined the currently generally accepted hardware intensity.
- In consideration of this mean value and by defining two extreme values, one higher and one lower, the utility function is linear.

As a result of the completed modelling, everything we need is available for selecting the, in its entirety, most suitable of the ICT investment alternatives available in a complex way.

Apart from the 'Academic' version I furthermore prepared an automated calculation worksheet entitled 'Enterprise', which is also available on the CD-ROM enclosed with my dissertation (*ERP minősítő modell_Enterprise.xls*). The background mathematical structures, although hidden for user enterprises, do operate in the background.

In consideration of all these, I accept hypothesis H5 as verified.

3.4.2. The multistage decision model

Nevertheless, I must emphasize that selecting the possible alternatives is a highly responsible task for any enterprise planning to implement the given investment. A task that requires extreme care and consideration. I did not set

the analysis of this aspect as a task for my dissertation. If we consider the tasks to be accomplished from this aspect, we can talk about a two-stage selection process.

The first stage is about 'filtering'. As part of this stage, we identify the ICT investment alternatives to be considered at all. When doing so, we will also need to apply constraints, e.g. if there is a production module within the integrated system if we are a producing company. Rózsa (2008) developed an excellent technique in his PhD dissertation for such filtering systems with respect to ICT investments.

The second stage is called 'ranking'. Here the aim is to select the best of the possible good alternatives and here we apply different ranking criteria.

Let me note that I have worked out a single-stage technique in my dissertation that contains no constraints, only ranking criteria. I opted for this direction since the ERP systems available on the market today are practically complete systems; they know everything in the given branch and corporate category. My multicriteria ICT valuation model does in fact perform some filtering indirectly since it unmercifully marks down all the systems lacking certain modules when the IT-related criterion checks the complexity of base and complementary modules and, consequently, such systems drop behind in the valuation.

3.4.3. Testing the multicriteria decision model

As a teacher of economic computer sciences, I lead a course on Business Management Software in each spring term for the graduating students of the Business Management Specialism. In the weekly practices of this course we review the integrated business management systems that are often used by domestic enterprises, both smaller and larger ones. In the spring term of the

school-year of 2010, we analysed the following 10 ERP systems with my technique:

- BUSINESS_OBJECTS, INFOR.COM, JOBSHOP, LIBRA 3s, OBJECT_NET, ORACLE, PIRAMIS, PROTEUS, SAP BUSINESS INFORMATION WAREHOUSE, and SAP BUSINESS ONE.

The findings are shown in Table 4. The above-listed kinds of software are coded in the valuation.

Table 4 Summary of terminal criteria valuation

Terminal criteria		Resulting scores									
Management service		**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**
Data provision		75	90	75	75	75	75	90	10	10	97
Decision support		97	99	50	97	90	100	97	90	90	75
Visualisation		50	50	3	25	3	50	50	3	3	10
Operator service											
Operative performance		33	48	69	48	33	48	100	48	48	22
Communicative performance		33	69	15	48	15	48	100	22	22	33
Helpdesk		15	22	15	33	1	48	15	6	6	15
Economic value of investment											
Net Present Value	NPV	50	50	50	50	50	50	50	50	50	50
Internal Rate of Return	IRR	50	50	50	50	50	50	50	50	50	50
Profitability Indicator	PI	50	50	50	50	50	50	50	50	50	50
Payback Period	PB	50	50	50	50	50	50	50	50	50	50
ICT supplier stability											
Supplier's business stability	46	71	46	100	9	100	71	25	9	71	
Supplier's references	46	10	46	100	25	100	71	46	9	100	
Software performance											
Base module complexity		47	90	47	47	17	100	33	62	62	47
Complementary module complexity		19	71	10	29	14	81	62	62	62	52
IT-related criterion											
Hardware intensity		50	50	50	50	50	50	50	50	50	50

Source: Own construction

When enterprise specific data was required, we assigned the average score of 50 utility scores to the given terminal criterion.

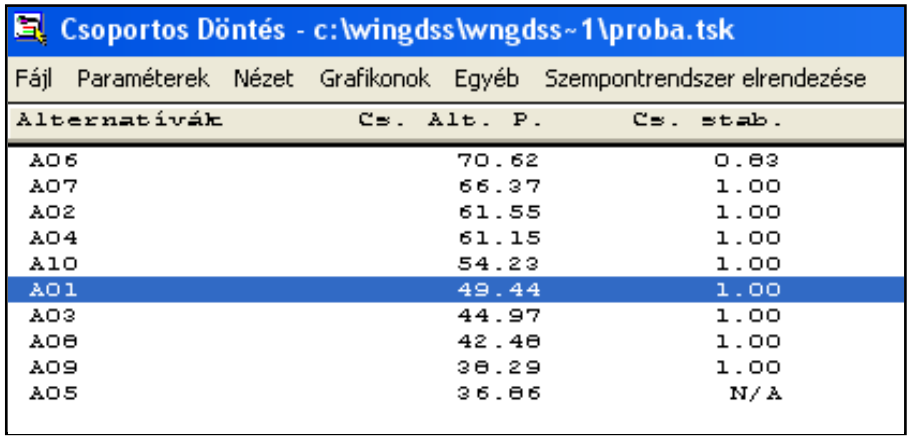
After we have done the utility scoring for each possible alternative and valuation criterion (terminal criterion), our next task was to aggregate the utility scores assigned by criterion for each alternative. Based on the resulting aggregate utility scores the alternatives could be ranked.

My 'Enterprise' model performs the aggregation based on weighted arithmetic mean as recommended by literature (Bozóki 2006, 38) automatically. Bearing in mind, however, that, from this point on, the process can be standardised, several professional aggregation software solutions are available to us of which I chose WinGDSS a Windows based group decision support system to define the final scores of the various alternatives.

WinGDSS is a complete decision support system developed by MTA SZTAKI (Computer and Automation Research Institute, Hungarian Academy of Sciences). The software was developed by a team lead by Mr Tamás Rapcsák that also provides detailed users' manual illustrated with examples (Rapcsák 2007a).

Having completed the tasks in the program with the data stated in Table 4, I received the results on the valuation of the different alternatives shown below in Figure 15. In this case, ICT investment alternative no. A06 was found the best.

Figure 14 The final scores of ICT alternatives



Source: Own construction using the WinGDSS software

The software is also able to perform *sensitivity* and *stability analyses*. They also yielded adequate results. We can therefore state that the process supported by the automated MS Excel-based calculation worksheet I developed is able to perform the comparative analysis of the most varied of ICT solutions and to generate the related ranking.

3.5. The economic value creation of ICT investments

3.5.1. Calculation schema

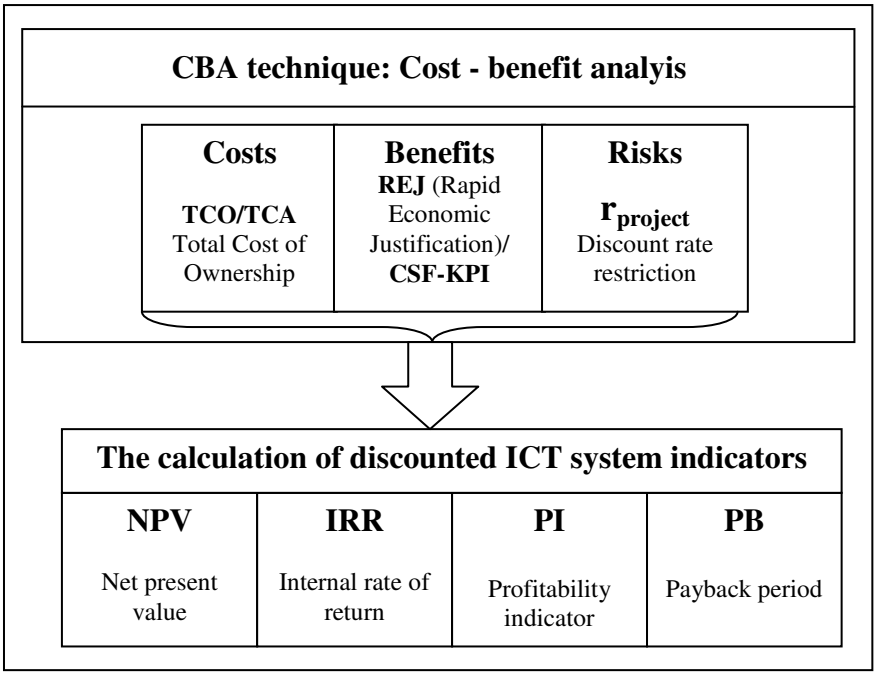
The Cost Benefit Analysis (CBA) serves as the model's framework. In this scope, I suggest defining *total costs* by the TCO (Total Cost of Ownership) method of the Gartner Group (Gartner 1999) that will define the total cost of ownership, what's more, will do so in a system of accounts that will perfectly correspond to the company's chart of accounts. Following the recommendations of Microsoft REJ (Rapid Economic Justification) (2005, 97), the item shall be modified to a small extent depending whether we perform an *ex ante* valuation of a planned ICT investments or a *mid term* valuation of an already operating system (the basic difference between TCA and TCO).

Utilities are defined quantitatively by the CSF/KPI method within the Microsoft REJ (Rapid Economic Justification) framework, which, as the name suggests, offers a fast definition of economic utility, but, in fact, is a methodology requiring intense attention. Risks shall be considered by defining the project's risk-free discount value.

3.5.2. The calculation of economic value creation

The simplified structure of my model is shown in Figure 16. I have prepared an MS Excel based automated calculation worksheet to assist the implementation of the process entitled *'ERP értékelő modell_Financial.xls'* (see the CD-ROM enclosed with the dissertation).

Figure 15 Calculation model for ICT economic value creation



Source: Own construction

Considering the above-described, I accept hypothesis H6 as verified.

4. CONCLUSIONS

Based on my research and methodological achievements, we have moved closer to the economic valuation of ICT systems. It can clearly be seen that there exists of set of criteria or a *hierarchy*, which is generally acceptable as an ICT valuation structure. Naturally, enterprises may mould this structure flexibly. Based on a survey, there exists a recommended structure for the *weights* of the various criteria, which can, however, be defined by enterprises at their own discretion too. A set of criteria can be developed to associate scores with the *terminal criteria* found at the bottommost level of the hierarchy and depending on the extent the ranking conditions are met, through the application of the utility function based on the decision makers' opinion, the utility score of the given terminal criterion can be defined. By aggregating the qualifying and weight values thus generated, we can get the summary utility scores of the different alternatives and therefore a rank order of the alternatives can be established.

Hence a flexible method becomes available for enterprises that can provide an assessable view of the utility of their ICT systems. Through the implementation of the technique, not only the professional comparison of various alternatives and selecting the best possible version can be done when planning ICT investments, but the financial evaluation of enterprises' existing ICT systems can also be performed.

Eventually, enterprises implementing the recommended techniques can consequently minimise the number of disputes over the utility of their ICT systems. In the case of planned investments, selecting one alternative is practically turned into a flat decision.

5. NEW RESEARCH RESULTS

5.1. New scientific results

1. I have constructed a *system of ICT valuation criteria* that can comprehensively consider the varied features of ICT systems (hierarchy).
2. I have worked out a *system of ICT valuation weights* based on primary research findings that can be used for business valuations.
3. I have created a *complex ICT valuation model* that is suitable for valuing ICT investment alternatives properly and is supported by decision theory and statistics, and with the help of which a more beneficial ICT solution can be selected relatively simply.
4. I have developed an *ICT economic value measurement model* relying on primary and secondary research findings, which is able to measure the utilities of operating ICT systems over their useful lives with practical precision.

5.2. Novel methodological results

1. If we analyse issues relating to special fields (the utility of ICT investments), we have to find the relevant population that is involved with the topic.
2. If we do exploratory primary research (in-depth interviews) within a special field (the utility of ICT investments), it is useful to direct our attention to medium-sized and large enterprises since we would expectedly not reach worthwhile results among microenterprises.

6. RECOMMENDATIONS

I recommend the application of the technique to any enterprise that would like to gain clearer insights in the field of ICT or want to select the, in its entirety, most beneficial solution prior to a prospective ICT investment based on its own situation and value-judgement.

I furthermore suggest the application of the developed technique in evaluating the ICT tender applications in the scope of the New Széchenyi Plan. Applicants are required to develop several aspects in their applications but no justification is required as to why they intend to implement the given ICT system. I could imagine that they be required to present the valuation of at least three different alternatives by completing the automated calculation worksheet and enclose the same with their tender applications. I know that they are already required to prepare extensive applications that can mostly be prepared by tendering consultants already. I find it possible that an enclosure to support the selected ICT alternative be also enclosed with the applications while simplifying the other sections. Enterprises' independence would not suffer by this since selecting any three alternatives to choose from would still belong to their personal competence. On the other hand, however, they win public funding and bearing that in mind, it would be rightful to have the various alternatives 'tendered' in a way.

A further recommendation would be to work out the ledger module for the TCO cost monitoring method of the Gartner Group that would harmonise with the Hungarian accounting rules.

Finally, I recommend developing a framework to survey the CSFs (Critical Success Factors) within Microsoft REJ (Rapid Economic Justification) that are typical of domestic enterprises as well as the key performance indicators (KPIs) improving the previous factors through ERP solutions in the scope of primary research, and to develop a system of typical action chains by assigning probability values to expected effect sizes.

7. SCIENTIFIC PUBLICATIONS ON THE PhD TOPIC

Foreign language article in a domestic scientific journal:

Szatmári, F., Antal, A. K. (2008): Business value creation in IT. Acta Oeconomica Kaposváriensis, Volume 2 No 1 2008, ISSN 1789-6924, pp. 33-48.

Szatmári, F. (2008): The financial return of IT investments. Szakmai Füzetek, BGF KKFK 2008. 22. szám, Budapest, ISSN 1587 5881, pp. 112-121.

Hungarian language article in a domestic scientific journal:

Szatmári, F. (2008): Az ERP rendszerek és a kontrolling informatikai támogatása. Acta Agraria Kaposváriensis, Volume 12 No 2 2008, ISSN: 1418-1789, CD kiadvány: *R:/08Szatmari.pdf*, pp. 83-96.

Szatmári, F. (2010): Közgazdasági értékteremtés vizsgálata a hazai vállalkozások infokommunikációjában. Acta Agraria Kaposváriensis, Volume 14 No 3 2010, ISSN 1418-1789, (*forthcoming*).

Proceedings published in domestic conference publications:

Szatmári, F. (2008): Közgazdasági értékteremtés az infokommunikációban. II. Terület- és vidékfejlesztési konferencia, Kaposvár 2008, ISBN 978-963-06-5394-7, pp. 90-95.

Szatmári, F. (2009): Közgazdasági értékteremtés az Európai Unió agrárinformációs rendszerében. 2nd International Economic Conference, Kaposvár 2009, ISBN: 978-963-9821-08-8, CD kiadvány: *file:///R:/cikkek/Szatmari.pdf*.

Szatmári, F. (2009): Közgazdasági értékteremtés vizsgálata a hazai vállalkozások infokommunikációjában. Tudományos Konferencia, Magyar Tudomány Napja, 2009. november 5-16. BGF Budapest 2009, CD kiadvány: *file:///R:/pdf/05_kozg/szekcio.html*.

Technical article in other journals or publications:

Szatmári, F. (2004): Integrált vállalatirányítási információs rendszerek (ERP) és a controlling informatikai támogatása (OLAP technológiák). BGF Tudományos Évkönyv, Budapest 2004, ISSN 1558-8401, pp. 35-52.

Szatmári, F. (2007): Az informatikai beruházások üzleti megtérülése./The Financial Return of IT Investments. Gyakorlat és Tudomány, BGF Tudományos Műhely kiadványa, Budapest 2007, pp. 185-204.

Szatmári, F. (2008): Korszerű közgazdasági értékteremtési formák a marketingben és az infokommunikációban. Üzlet és tudomány, BGF PSZK Budapest 2008, ISBN 978-963-7167-08-9, pp. 173-182.

Domestic conference presentation:

Szatmári, F. (2007): Az informatikai beruházások üzleti megtérülése. Tudományos Konferencia, Magyar Tudomány Napja, 2007. november 8-9. BGF Budapest.

Szatmári, F. (2008): Korszerű közgazdasági értékteremtési formák – Marketing és infokommunikáció. Tudományos Konferencia, Magyar Tudomány Napja, 2008. november 6-7. BGF Budapest.

Szatmári, F. (2009): Közgazdasági értékteremtés vizsgálata a hazai vállalkozások infokommunikációjában. Tudományos Konferencia, Magyar Tudomány Napja, 2009. november 5-16. BGF Budapest.

Szatmári, F. (2010): Közgazdasági értékteremtés vizsgálata a hazai vállalkozások infokommunikációs beruházásainál. 10. Tudományos Konferencia, Magyar Tudomány Ünnepe, 2010. november 4-5. BGF Budapest.