

**THE ECONOMIC ANALYSIS OF THE MANAGEMENT
INFORMATION SYSTEMS**

DOKTORAL (PhD) THESIS

Written by
Zsigmond Gábor Szalay

Szent István University
Gödöllő, 2009.

Name of the PhD school:

PhD School of Management and Business
Administration

Scientific branch of the PhD school:

Management and Business Administration

Head of PhD school:

Dr. István Szűcs
doctor of MTA
SZIU Faculty of Economics and Social Sciences
Institute of Economy Analysis and Methodological

Head of Research:

Dr. Csaba Székely
doctor of MTA
SZIU, Faculty of Economics and Social Sciences
Institute of Business Economics and Management

.....
Approval of the head of the PhD
school

.....
Approval of the consultant

1. INTRODUCTION

1.1. The importance and actuality of the project

Recently enterprise executives handled informational developments as a secret weapon, it was preferred to other investments, and financial sources can be ensured through less effort. Nowadays, the impulse of this process has decreased; investment-economic examinations of IT developments and assessment of returns have come to front. However, cost items of these developments and extraordinarily special profit elements represent more difficult task than average ones.

Practical researches deal with the introduction of Management Information Systems (MIS) can be classed among three huge trends. Studies belong to the first trend identifies those factors that have positive influence on successful introduction, considering how huge task the introduction of an information system is. For example, Stratman and Roth (2002) explain the success of introduction with a so-called competence model. This model contains organizational capabilities like executive commitment and changing management. Mabert et al. (2003) concluded that introduction of MIS is realized in the given time and cheaper than it is projected, is typically due to the fact company spent more time on planning before introduction, and installed less system-configurations. Bradford and Florin (2003) theorized the successful spread of innovation and information systems, and determined that qualification of employees working in the management information system and market pressure urging the system introduction are the factors that have positive influence on successful introduction.

Researches belonging to the second trend show that the market reacts positively at news of MIS introduction, and MIS introduction reckoned to be a factor that increases the market value of the company. Achieve results of Hayes et al. (2001) showed positive, abnormal, and cumulative outturn in case of the sample collected from MIS introducing enterprises. They concluded that investors expected MIS introduction to increase positive, net cash-flow for the future. Hunton et al. (2002) concluded that analysis alter positively the input forecast of the company at news of the MIS introduction. These results also show that expectations of investors conform to the practical evidences that confirm possible benefits of management information systems (for instance: publication of real-time data, improving customer relationship management, shorter time periods) (Brown 1997; Glover et al. 1999; Wah 2000).

Researches belong to the third trend analyse whether MIS introduction improve operational performances. By utilizing accountancy-based performance indicators (for example: financial ratio) these researches usually closed with miscellaneous results, regarding the relationship between the introduction of

MIS and the following performances, (Poston, Grabski 2001; Hitt et al. 2002; Hunton et al. 2003; Nicolaou 2004; Wier et al. 2005). At the same time these researchers concluded that positive coherences become more obvious 2-3 years after introduction, when performances of MIS applying and non-applying enterprises were compared, if MIS appliers do not apply financial incentives in leading circles and control MIS distributor and entered modules.

Trends mentioned above have in common that accountancy information play a critical role in case of management information system. In case of MIS appliers the system is responsible for creating those accountancy information (for example: financial statements) that are used for the following purposes: measuring the success of MIS introduction, supplying the external users with financial information, and determining the operational performance.

1.2. Aims and tasks

The MIS introduction causes several problems because lack of the knowledge about the so-called best practises. When an enterprise decides to buy a new MIS it should be aware of numerous factors. The project has several difficulties but at the same time many profits. It is not common any more that companies do not expect considerable return from this investment, and at the same time the investment-analysing is considerably unsatisfied, in spite of the fact the investment is often significant.

Since the cost-effectiveness become more and more emphatic, detailed investment-analysis can be more important in order to detect, whether the MIS project is profitable or not. The MIS has to be handled like other investments that have to meet requirements concerning ROI and positive cash flow.

The aim of the dissertation is to discover problems in economic interpretation of management information systems, to introduce those international results and methods which can be acceptable starting-point in connection with the topic. Based on the results mentioned above and on own experiences, the research proposes to review techniques applicable in Hungary. Moreover, experimental work proposed to establish a database, which meet the requirements of international research directives and ensures a chance to discover statistic coherences in the topic. Furthermore, our aim is to create an economic analysing model that is able to take into account the specific cost-effectiveness of management information systems and provide forward-looking appliance for executives to fulfil economic evaluation of enterprise information systems both on theoretical and practical level.

1.2.1. Research hypothesis

Tasks of management information systems are to systematize and to structure information resources of the enterprise in order to improve considerably the effectiveness of the enterprise. On this assumption, a well-planned and operated

management information system has to have demonstrably effect on the enterprise operation. These effects – among others – can be measurable by financial performance indicators of enterprises.

Hypothesis 1: In this case hypothesis is defined as financial performance indicators of enterprises are going to improve compared to performance indicators before introduction. Since statistical hypotheses are referred to sameness, so during tests – in indirect way – we are looking for the constancy in long-term financial performance indicators.

As an expectation can be defined that the hypothesis testing disapproves the statistical hypothesis, but approves the research hypothesis, namely, statistically significant improvement can be found.

In case of control-group that does not introduce management information system, statistically proved improvement of financial performance indicators is not expected. In this case, the hypothesis of the researcher and the statistical hypothesis are the same.

Hypothesis 2: Long-term financial performances of those enterprises do not introduce management information systems remained unchanged by comparison themselves.

Similarly researcher expectation can be a complex system set up by already existing MIS economic models. With this system, improvements of financial performance indicators can be supported, or financial performance indicators can confirm profit defined by the model.

1.2.2. Description of the research

- 1) Establishment of a new, appropriate database and its analysis with the SPSS program
 - Research planning (sample taking, methods)
 - Establishing sample introduced ERP (sectoral partition) (n= 72items)
 - Compiling control samples with similar combination (matching)
 - Preparation of descriptive statistics
 - Normality tests
 - Selection of the appropriate statistical tests and applications
- 2) Preparation of ERP ROI calculator
 - Preparing system-plan
 - Programming
 - Testing
 - Application
 - Discussion of results
- 3) Comparing accountancy indexes of the database with results supplied by the ROI Calculator.

2. MATERIALS AND METHODS

2.1. Description of experimental materials

2.1.1. The sample and the sample-taking process

For planning of sample-taking, basically methods from studies of Hayes et al. (2001) were applied. The appearance of profit gained from introducing ERP system takes years in most cases, thus, only those enterprises were added to the sample, which have financial data for the last 3 years since ERP was introduced. Because of this restriction those enterprises were not added to the sample, whose ERP systems were introduced after 2004. In favour of compare different periods, samples were taken financial performance of enterprises from 3 years before and 3 years after introduction. As a result of this restriction, 72 enterprises were added to the final sample. (Further it will be mentioned as ERP-enterprise group.)

By analysing effect of the ERP application for the financial performance, considering effects of macroeconomic factors is expedient. For implementation, a control group that did not introduce ERP system was formed. (Further it will be mentioned as NON enterprise group.) Former studies analysing financial performances of enterprises applied the so-called SIC code (Standard Industrial Classification) for matching enterprises. In present research, the industrial classification was fulfilled by principal activity of enterprises according to TEÁOR. Table 1. shows distribution of enterprises.

Table 1.: Classification of enterprises that take part in the examination

Sector	Number
Commercial	31
Producer	41
Total	72

The huge size of the sample made statistical tests according to industry impossible. The classification and the registration were utilized in NON enterprise group; as a result of it, both enterprise groups (ERP, NON) contain items from both classification category to the same extent.

For the purpose to improve matching of both samples, T_0 was introduced namely the net turnover in the year of introduction. Terms were, that the total net turnover of the NON enterprise group can not differ more than 10% to the total net turnover of the ERP group, and the difference in part-results of industry have to be less than 30%. Based on Table 2., the total net turnover of the ERP enterprise group was 190 million HUF, while in case of NON group it

was 176 million HUF, so the difference was 7,2%. The differences were higher in industrial distribution, but they compensated each other.

Table 2.: Total net turnover and its differences at ERP-introducing (ERP) and not introducing (NON) enterprises

a) Total net turnover at ERP-introducing and not introducing enterprises	ERP	190 418 498
	NON	176 672 020
b) Difference between the summarised sums (base: ERP)	Sum	13 746 478
	Percentage	7,2%
c) Net turnover of ERP introducing enterprises (ERP) per sectors	Commercial	81 654 078
	Producer	108 764 420
	Total	190 418 498
d) Net turnover of ERP not introducing enterprises (NON) per sectors	Commercial	87 596 101
	Producer	89 075 919
	Total	176 672 020
c) Numerical difference between the two above-mentioned samples (base: ERP)	Commercial	-5 942 023
	Producer	19 688 501
	Total	13 746 478
d) Difference between the two above-mentioned samples expressed in percentage (base: ERP)	Commercial	-7,3%
	Producer	18,1%
	Total	7,2%

2.1.2. Names of variables

During the experimental work, the year introducing ERP was labelled as T_0 . In case of NON enterprise group, this period was derived from the introduction year of matched items in ERP group. Data was collected plus or minus three years comparing to this period. Due to the restriction in connection with names of SPSS parameters, '+' has to be changed to 'p' that is applied hereafter. The average of 3 years after T_0 was named as 'aft', while the average of 3 years before T_0 was named as 'bef'. The first parts in name of variables are determined by enterprise groups (ERP, NON) they belonged to, and the last part of them allude to financial performance indicators that were analysed. The XYZ can be identified as ROA, ROS, ATO and ROE indexes. (Table 3.)

2.1.3. Description of ROI calculator appliers

A ROI calculator was sent out to 72 ERP-introducing enterprises in an Excel table. Management of the enterprises applied the calculator with the help of general instructions; moreover, they had a chance to ask via telephone and e-mail. Based on these iterations 40 appropriate calculations were fulfilled which may be considered as the second period of the experimental work.

Table 3.: Names of variables (source: own work)

Duration	ERP	average	NON	average
T0+3 (Tp3)	ERP_Tp3_XYZ	ERP_aft_XYZ	NON_Tp3_XYZ	ERP_aft_XYZ
T0+2 (Tp2)	ERP_Tp2_XYZ		NON_Tp2_XYZ	
T0+1 (Tp1)	ERP_Tp1_XYZ		NON_Tp1_XYZ	
T0	ERP_T0_XYZ		NON_T0_XYZ	
T0-1	ERP_Tm1_XYZ	ERP_bef_XYZ	NON_Tm1_XYZ	ERP_bef_XYZ
T0-2	ERP_Tm2_XYZ		NON_Tm2_XYZ	
T0-3	ERP_Tm3_XYZ		NON_Tm3_XYZ	

2.2. Introduction of comparative analysis of the ERP-introducing and not introducing enterprises

For assessing the performance a method can be the financial statement analysis that applies traditional accountancy indicators. The bases of these indicators are the connection among items of the financial statement. In the present case the four applied performance indicators have come into prominence. In selection process indicators were taken in consideration, which were mentioned in references and were calculated in certified studies, herewith helping the comparability. Country specified items of accountancy rules and practise mean definite difficulty in this experimental area. (Figure 1.)

Indicator	Description
ROA	Net turnover of assets without extraordinary items (available by stockholders) divided by the average of initial and final total assets. (Compustat multiplies this rate by 100.)
ROS	Turnover proportional profit without extraordinary items (available by stockholders) divided by net turnover of the appropriate.
ATO	Turnover rate of assets and the net turnover of the appropriate period divided by the average of initial and final total assets.
ROI	Return of investment without extraordinary items (available by stockholders) divided by the sum of long-term financial debts, preferred stocks, minority shares, capital. (Compustat multiplies this rate by 100.)

Figure 1.: Description of indicators in course of a similar research conducted in USA
[Source: Hunton, 2002]

The first indicator is 'return on assets' (ROA) that is often applied by scientists as the enterprise performance indicator. [Balakrishnan et al., 1996] [Barber et al., 1996] [Barua et al., 1995] [Bharadwaq, 2000] [Hitt and Brynjolfsson, 1996] [Weill, 1992]. Since ROA combines enterprise profitability and effectiveness, it is proved to be a considerably useful and a general performance indicator. [Skousen et al., 1998] ROA plays highly important role during the analysis, because it can be got easily from the accountancy and can describe the assumption that applying ERP systems caused increased effectiveness and profitability. [Brakely, 1999] [Schaeffer, 1996] [Stein, 1998] [Vaughan, 1996] [Wah, 2000].

$$\text{ROA (Return on Assets)} = \text{Result of operational activities} / \text{total asset}$$

During planning of examination the original taxed indicator in the numerator of ROA indicator was changed to results of operational performance. Hence, distorting effect that was caused by results of financial operation may have been eliminated. Since analysed population considering its principal activities are out of the financial market, the effect of introduced ERPs can be followed more easily through results of operational activities. In case of total assets in the denominator – because of the logic mentioned above – the line of commercial papers are also eliminated. Deferred charges are also taken out since samples overlap more periods can distort own performances of each period. For these reasons total assets contain the followings items: intangible assets, tangible assets, stocks, debts, budgets.

Common effects of profitability and effectiveness represented by ROA can be divided into ROS (profitability of net turnover) and ATO (turnover rate of assets). Values of these two secondary performance indicators were calculated during the experimental work. ROS is the profits refer to 1 HUF income, which expresses the profitability or mark-up of the enterprise ATO is the income generated by assets refer to 1 HUF, which expresses the effectiveness of assets. Category of taxed results in the numerator of ROS has been changed to results of operational activities, because of distorting effects of financial activities.

$$\text{ROS (Return on Sales)} = \text{result of operational activity} / \text{net turnover of sales}$$

$$\text{ATO (Assets Turnover)} = \text{net turnover of sales} / \text{total asset}$$

In case of ATO total asset was calculated on the based of the protocol mentioned above.

The last performance indicator, which was calculated during the experimental work, was ROE (Return on Equity). ROI (Return in Investment) mentioned by international references was altered to ROE. [Mabert et al., 2000] [Stedman, 1999] [Stein,1998]. The alteration was justified, as similar international

experimental works, mainly conducted in the United State, ROI are calculated by the following way:

$$\text{ROI} = (\text{Return of investments} - \text{Extraordinary items}) / (\text{Long-term financial debts} + \text{Preferred Stocks} + \text{Minority shares} + \text{Capital})$$

(Compustat multiplies this rate by 100.) [Hunton, 2002]

For the purpose to compare results, application of ROE (Return on Equity) that is recoverable more easily from the Hungarian balance sheet data was expedient

$$\text{ROE (Return on Equity)} = \text{result of operational activity} / \text{capital}$$

2.3. Introduction of Management Information System ROI calculator

The base of the model were the Nucleus Research ERP ROI Tool and the investment-profitability models developed at Department of Economics (Invest) The calculator consists of 5 main modules: Cost, Benefit, Parameter, Summary, Report, as it is shown in the Figure 2.. A payback period of 3-5 years is to be examined in case of information projects. The model applies a 5 year period to adopt to Hungarian circumstances.

The calculator makes it possible to gather and systemize the costs connected to information systems. Of the three main cost components (software, hardware, service) the third, i.e. service is included only accumulated in the Report module. To make identification easier, there are 4 points within Cost module: consultancy, wages, training, and other service costs. Although depreciation percentages a shown in the figure at Parameter as they belong to that module, they can be set separately at hardware and software for practical reasons. The program advances the depreciation report of Summary module, and shows directly the depreciation amounts of five years.

The Benefits module makes it possible to input all the profit increasing factors. It has two major parts: direct, and indirect factors. Management information systems improve the turnover of stock, improving the returns of profits. At the same time, a higher level of sales can be achieved by improving the processes, which requires higher level of stock. By determining their common effect we may find the effects of the information system on the stock. This double effect is taken into account by the model, and makes it possible for the user to change their percentage. The model organizes the effect of the information system as follows.

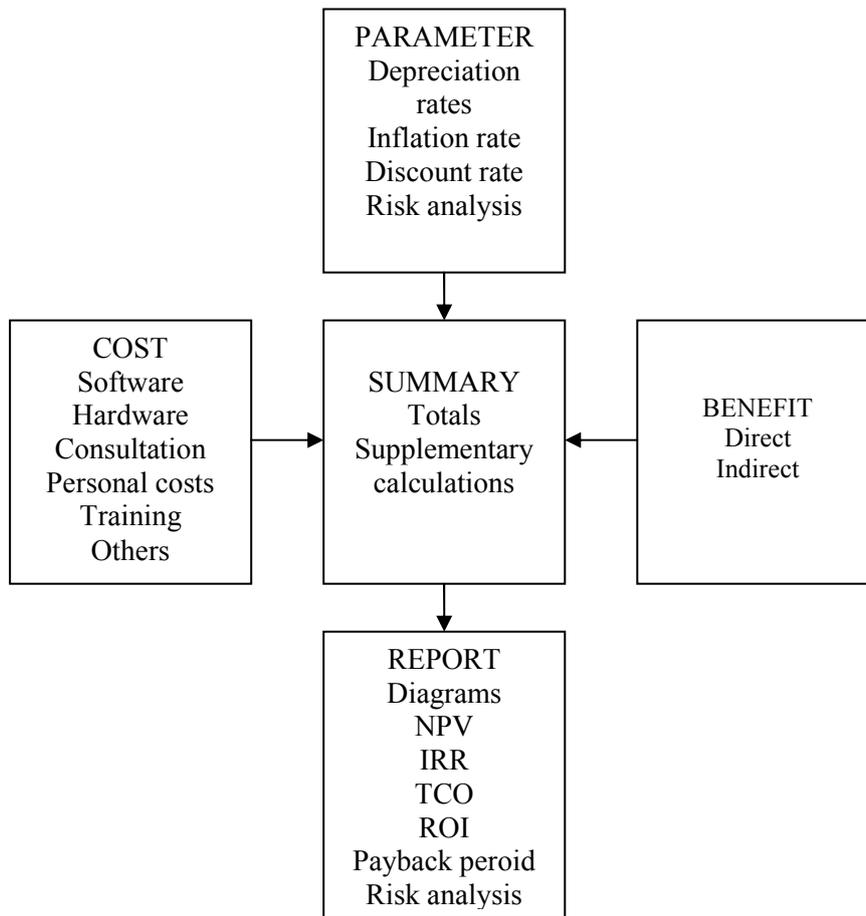


Figure 2.: Flow diagram of MIS ROI calculator (Source: own work)

The model systemizes effects of information systems on enterprise effectiveness:

Direct profit:

- Decreased inventory costs
- Increased order of distributors
- Increased cross-sell
- Decreased administrative costs
- Increased effectiveness of sales
- Decreased applied wage
- Decreased printing and postage costs
- Decreased sales costs
- Increased turnover
- New income sources:
 - New market channels (e-business)

- Direct connection with the IT system of customers
- Electronic invoice representation
- More accurate forecasts

Indirect profit:

Increasing effectiveness:

- Development of information system
 - Decreased management costs
 - Decreased administrative costs
 - Decreased marketing costs
 - Decreased repeated production
 - Decreased communication costs
 - Decreased time devoted to market monitoring
 - Improved productivity
 - Decreased disorganization
 - Decreased training costs
 - Decreased inventory costs
 - Decreased stock level
- Development of technology-management
 - Decreased management costs
 - Decreased integrating-time
 - Decreased developing costs
 - Decreased system-maintenance costs
 - Decreased infrastructure costs
- Development of process management
 - Decreased management costs
 - Decreased administrative costs
 - Decreased costs of errors and omissions
 - Decreased communication costs
 - Decreased sales costs
 - Decreased training costs
- Improvement of customer- and partner-communication
 - Decreased communication costs
 - Decreased stockpiling
 - Decreased time for market monitoring
 - Decreased logistic costs
 - Decreased product rework
 - Decreased customer care costs
 - Decreased penalty

Summary module shows the accumulated amount of costs and benefits, and the basics of the ROI calculations of Report module are also shown here.

Parameters module can accept the annual inflation effects, which is an important factor as the examined period lasts for 5 years. The parameters of the risk assessment part of the model are also in this module. The examined aspects are: Investment rate, which is the ratio of ROI and payback period; ROE, which equals payback period, but represents different risks for different scales; and Indirect and total benefits. The latter is the most special aspect of information systems. The program also makes it possible to change the interest rate stepwise, which makes it possible to examine the sensitivity of net present value. The original interest rate is changed in two steps up and down, the delta value of which can be changed.

Report module includes the tabular and graphic representation of the sensitivity analysis, and shows the proportion of direct and indirect benefits of the project, investment cost, and the related depreciation costs. The proportion of the costs can be compared to those shown in a research on the costs of installation of information systems in Hungary, like a benchmarking.

During profitability analysis the following indicators are calculated:

- Annual ROI – direct and indirect profit
- Net cash flow after taxation (direct)
- Annual ROI – direct profit
- Net present value (NPV)
- Return time (in years)
- Total cost of ownership (TCO)
- Average TCO
- Cumulative ROI
- Internal rate of return

Riskiness of the project was estimated by three indicators described above; during estimation each indicator are classified into low, medium, and high risk category.

One of the most popular profitability indicators at informational projects is the total cost of ownership that is presented graphical too.

2.4. Connection of analysing ROI calculator and financial performance indicators

Description of analysis:

1. Selection of ERP-introducing enterprises (72 pieces)
2. Determining characteristics of the group mentioned above
3. Collecting the control group based on the determined characteristics
4. Calculating values of financial performance indicators

5. Determining statistical characteristics, preparing descriptive statistic, running a test
6. Applying ERP ROI Tool Kit on the ERP enterprise group (40 pieces out of 72)
7. Discussing results

The ROI model in se is able to economic evaluation of management information system. For analysing results of financial indicators, more samples have to be ensured. The model was sent to 72 ERP-introducing enterprises that took part in the analysis of financial indicators. To improve distance and inclination to fill forms, simplification was reasonable. The most significant simplification was expedient in case of indirect profits. In this case the program asked values of main group items, in point of internal values percentages were enough. This alteration did not have an effect on calculation of returns; nevertheless, it meant considerable improvement for person who completed it. Moreover, this did not block the calculation of mean values.

3. RESULTS

3.1. 3.1 Matching financial performance indicators of the ERP-introducing and not introducing enterprises

3.1.1. Analysis of statistical data before the introduction period

3.1.1.1. Descriptive statistic

Table 4. represents the average of financial performance indicators, mean values and deviation (n=72) of ERP-introducing (ERP) and not introducing (NON) enterprises before three years (T-3, T-2,T-1) of introduction (T0). Values of delta column represent the difference among ERP-introducing enterprises (ERP), furthermore, next to this column percentages of difference can be found.

Table 4.: Financial performance indicators of ERP-introducing (ERP) and not introducing (NON) enterprises from three years before introduction, their differences expressed in absolute (delta) and percent values (Source: own work)

Durat.	Indic.	ERP			NON			delta		%	
		Average	Median	Disper.	Average	Median	Disper.	Average	Median	Average	Median
T-3	ROA	10,82	8,29	6,90	12,06	7,85	9,96	-1,24	0,44	-11,46	5,36
T-3	ROS	4,39	4,09	1,84	5,13	4,56	2,44	-0,74	-0,47	-16,81	-11,59
T-3	ATO	2,67	2,17	1,55	2,38	1,82	1,71	0,29	0,35	10,90	16,12
T-3	ROE	18,26	11,86	24,98	19,61	10,41	24,39	-1,35	1,45	-7,39	12,22
T-2	ROA	10,27	8,72	5,87	12,27	8,14	10,08	-2,01	0,58	-19,56	6,61
T-2	ROS	4,22	4,06	1,81	5,15	4,43	2,75	-0,93	-0,37	-21,98	-9,12
T-2	ATO	2,66	2,32	1,39	2,46	2,08	1,62	0,20	0,25	7,54	10,66
T-2	ROE	17,40	10,58	23,96	20,49	10,48	28,83	-3,09	0,10	-17,77	0,96
T-1	ROA	10,57	8,77	6,55	12,01	8,18	10,30	-1,45	0,59	-13,68	6,75
T-1	ROS	4,42	4,05	2,17	5,13	4,17	3,23	-0,72	-0,12	-16,21	-3,02
T-1	ATO	2,62	2,05	1,47	2,53	2,02	1,76	0,09	0,03	3,44	1,58
T-1	ROE	17,18	11,44	21,40	20,62	11,60	29,72	-3,43	-0,17	-19,97	-1,45

Table 5. contains averages of financial performance indicators of three period represented in Table 4. Considering the experimental work, this table is significantly important (n=72, t=3) since items of periods are compared to table containing average values that represents the past comply with one time period (BEF: before). Base variables applied during statistic tests can be identified by this table. (ERP_bef_ROA, ERP_bef_ROS, ERP_bef_ATO, ERP_bef_ROE, NON_bef_ROA, NON_bef_ROS, NON_bef_ATO, NON_bef_ROE).

Table 5.: Financial performance indicators of ERP introducing (ERP) and not introducing (NON) enterprises in the average of three years before introduction, their difference expressed in absolute (delta) and percent values. (Source: own work)

Durat.	Indic.	ERP			NON			delta		%	
		Average	Median	Disper.	Average	Median	Disper.	Average	Median	Average	Median
BEF	ROA	10,55	8,68	6,31	12,11	7,78	9,97	-1,56	0,90	-14,83	10,39
BEF	ROS	4,34	4,20	1,84	5,14	4,43	2,71	-0,79	-0,22	-18,28	-5,25
BEF	ATO	2,65	2,19	1,41	2,46	1,92	1,66	0,19	0,27	7,32	12,51
BEF	ROE	17,61	11,57	23,28	20,24	11,43	27,36	-2,63	0,14	-14,90	1,20

3.1.1.2. Normality test

Table 6. shows that average financial performance indicators of the period before T0 in cases of ERP-introducing and not introducing enterprises in 50–50% give normal distribution at 5% significant level. Characteristics below were taken into account during the selection of hypothesis-testing.

Table 6.: Kolmogorov-Smirnov one-sample test for normality of financial performance indicators of ERP-enterprises and NON-enterprises before T0 (Source: own work)

BEF	ROA		ROS		ATO		ROE	
	Asymp.	Norm.	Asymp.	Norm.	Asymp.	Norm.	Asymp.	Norm.
ERP	0,003	nem	0,070	igen	0,086	igen	0,000	nem
NON	0,000	nem	0,009	nem	0,001	nem	0,000	nem

3.1.1.3. Homogeneity test

Before analysis, it is important to determine if samples of ERP-introducing and not introducing (NON) enterprises derived from the same basic population, thus, two enterprise groups can be reckoned homogeneous based on their financial performances. The normality test determined variables that can be analyzed by parametric and non-parametric tests. Table 7. contains summary results.

Table 7.: Normality of variables before the introduction period and correlations of applicable tests

Indicaior	ERP	NON	Test
ROA	no	no	Wilcoxon
ROS	yes	no	Wilcoxon
ATO	yes	no	Wilcoxon
ROE	no	no	Wilcoxon

Based on Wilcoxon tests the four indexes (ROA [0,801], ROS [0,148], ATO [0,149], ROE [0,755]) can be considered identical, which is represented in

Table 8. In case of ROA and ROE strong sameness can be discovered whereas in case of ROS and ATO this sameness is weaker, but these values are still acceptable. Basic population of four financial performance indicators considered homogenous, thus appropriate to math with financial performance indicators of ERP-introducing and not introducing enterprises, in the interest of being the ground for possible varieties in performance of the two different enterprise groups

Table 8.: Homogeneity test of ERP-introducing and not introducing enterprises before T0 time period with Wilcoxon test in respect of financial performance indicators

	NON_bef_ROA - ERP_bef_ROA	NON_bef_ROS - ERP_bef_ROS	NON_bef_ATO - ERP_bef_ATO	NON_bef_ROE - ERP_bef_ROE
Asymp. Sig. (2-tailed)	0,801	0,148	0,149	0,755

3.1.2. Statistical test of data received after introduction

3.1.2.1. Descriptive statistic

Table 9. represents financial performance indicators of ERP enterprises after introduction and speculative indicators of NON enterprises after introduction, which determined by statistical matching. Moreover, it contains differences and their percent values considering ERP enterprises as basis.

Table 9.: Financial performance indicators of ERP-introducing (ERP) and not introducing (NON) enterprises in the three years period after introduction and their differences expresses in absolute (delta) and percent values. (Source: own work)

Durat.	Indic.	ERP			NON			delta		%	
		Average	Median	Disper.	Average	Median	Disper.	Average	Median	Average	Median
T+1	ROA	11,24	9,69	6,89	11,63	8,22	9,84	-0,40	1,47	-3,52	15,19
T+1	ROS	4,50	3,98	2,52	5,29	4,41	3,65	-0,80	-0,44	-17,69	-10,96
T+1	ATO	2,79	2,35	1,78	2,42	1,94	1,79	0,37	0,41	13,21	17,44
T+1	ROE	18,47	11,35	25,81	19,94	11,48	25,68	-1,47	-0,14	-7,95	-1,19
T+2	ROA	11,38	9,43	7,70	11,74	8,12	9,34	-0,36	1,31	-3,20	13,91
T+2	ROS	4,69	3,93	3,69	5,59	4,31	4,78	-0,90	-0,38	-19,13	-9,78
T+2	ATO	2,79	2,37	1,72	2,46	1,86	1,93	0,34	0,51	12,04	21,51
T+2	ROE	20,52	12,30	32,75	21,01	11,96	27,22	-0,50	0,34	-2,43	2,73
T+3	ROA	11,38	9,29	8,17	11,08	8,20	9,04	0,30	1,09	2,67	11,77
T+3	ROS	4,52	3,95	3,68	5,31	4,28	4,16	-0,79	-0,34	-17,49	-8,54
T+3	ATO	2,89	2,51	1,94	2,44	1,86	2,13	0,45	0,65	15,59	25,85
T+3	ROE	20,07	11,76	33,33	20,42	11,09	27,65	-0,35	0,67	-1,74	5,73

Variables required for statistical tests can be determined as the following way that can demonstrate changes of financial performances caused by the introduction of ERP system:

ERP_Tp1_ROA, ERP_Tp1_ROS, ERP_Tp1_ATO, ERP_Tp1_ROE,
 ERP_Tp2_ROA, ERP_Tp2_ROS, ERP_Tp2_ATO, ERP_Tp2_ROE,
 ERP_Tp3_ROA, ERP_Tp3_ROS, ERP_Tp3_ATO, ERP_Tp3_ROE,
 NON_Tp1_ROA, NON_Tp1_ROS, NON_Tp1_ATO, NON_Tp1_ROE,
 NON_Tp2_ROA, NON_Tp2_ROS, NON_Tp2_ATO, NON_Tp2_ROE,
 NON_Tp3_ROA, NON_Tp3_ROS, NON_Tp3_ATO, NON_Tp3_ROE.

Table 10.: Financial performance indicators of the ERP-introducing (ERP) and not introducing (NON) enterprises in the average of three years after introduction and their difference expresses in absolute (delta) and percent values. (Source: own work)

Durat.	Indic.	ERP			NON			delta		%	
		Average	Median	Disper.	Average	Median	Disper.	Average	Median	Average	Median
AFT	ROA	11,33	8,99	7,41	11,48	7,87	9,28	-0,15	1,12	-1,34	12,49
AFT	ROS	4,57	3,94	3,21	5,40	4,51	4,08	-0,83	-0,57	-18,12	-14,56
AFT	ATO	2,83	2,31	1,78	2,44	1,79	1,92	0,39	0,52	13,64	22,51
AFT	ROE	19,69	12,08	30,43	20,46	11,36	26,45	-0,77	0,72	-3,92	5,96

Table 10. ensures comparison of average performance indicators in three years after T0 and financial performance before introduction.

If significant differences can be observed among systematically matched variables during hypothesis analysis, difference will be determined by comparison of average values based on descriptive statistic, which is represented in Table 9.

3.1.2.2. Normality tests

Before the statistical tests applied for hypothesis testing on financial performance indicators of ERP and NON enterprises after introduction normality of variables have to be analysed. To determine this **Kolmogorov-Smirnov one-sample test** was applied. Table 11. and 12. demonstrate results of tests. Only four parameters out of 32 show characteristics of normality tests.

Table 11.: Kolmogorov-Smirnov one-sample testing on financial performance indicators of ERP-enterprises after T0 (Source: own work)

ERP	ROA		ROS		ATO		ROE	
	Asymp.	Norm.	Asymp.	Norm.	Asymp.	Norm.	Asymp.	Norm.
T+1	0,098	yes	0,015	no	0,038	no	0,000	no
T+2	0,068	yes	0,000	no	0,108	yes	0,000	no
T+3	0,026	no	0,000	no	0,002	no	0,000	no
AFT	0,062	yes	0,000	no	0,036	no	0,000	no

Table 12.: Kolmogorov-Smirnov one-sample testing on financial performance indicators of NON enterprises after T0 (Source: own work)

NON	ROA		ROS		ATO		ROE	
	Asymp.	Norm.	Asymp.	Norm.	Asymp.	Norm.	Asymp.	Norm.
T+1	0,000	no	0,005	no	0,001	no	0,000	no
T+2	0,000	no	0,001	no	0,001	no	0,000	no
T+3	0,001	no	0,000	no	0,000	no	0,000	no
AFT	0,000	no	0,000	no	0,000	no	0,000	no

Results of normality tests in combined form are shown in Table 13. It can be determined that there is no indicator or period appropriate for parametric test.

Table 13.: Normality summary of financial performance indicators in case of ERP and NON enterprises after introduction

	ROA		ROS		ATO		ROE	
	ERP	NON	ERP	NON	ERP	NON	ERP	NON
T+1	yes	no						
T+2	yes	no	no	no	yes	no	no	no
T+3	no							
AFT	yes	no						

Professional literature considers more important examination, when performance of each enterprise groups after T0 is compared to the initial production, than ERP is compared to NON enterprise group. Selecting the appropriate statistical test, the common normality test of variable items set up by initial items (BEF) and performance indicators after T0 is necessary. On the base of Table 14. and 15. normality can be determined in only one case, when precaution can be improved by parametrical analysis.

Table 14.: Normality summary of variables after BEF and T0 in case of ERP enterprise groups [Source: own work]

ERP	ROA		ROS		ATO		ROE	
	BEF	Norm.	BEF	Norm.	BEF	Norm.	BEF	Norm.
T+1	no	yes	yes	no	yes	no	no	no
T+2		yes		no		yes		no
T+3		no		no		no		no
AFT		yes		no		no		no

Table 15.: Normality summary of variables after BEF and T0 in case of NON enterprise groups [Source: own work]

NON	ROA		ROS		ATO		ROE	
	BEF	Norm.	BEF	Norm.	BEF	Norm.	BEF	Norm.
T+1	no	no	no	no	no	no	no	no
T+2		no		no		no		
T+3		no		no		no		
AFT		no		no		no		

3.1.3. Matching of financial performance indicators in years before and after introducing ERP

Results of statistical tests conducted in years before and after enterprises introduced ERP are presented in table 16. By analysing the numerical values of matched, non-parametric test (Wilcoxon test), significant differences in case of ROS and ROE indexes can not be observed in neither time period. Difference between matched mean values before and after introduction is described significant at the 10% level regarding ROA and ATO indexes. In case of industrial activity / total assets (ROA) index specifically strong effect is pointed out, while in case of net turnover / total assets (ATO) the effect is weaker, however, the effect is unambiguously showed in the statistical test [0,094]. Recovery was observed for both specific indexes by analysing mean values belong to values that indicate discrepancies. In case of ROA mean value was 10,55 before introduction, it increased to 11,33 relative to mean values after introduction, whereas in case of ATO value of 2,65 increased to 2,83 by analysing similar terminuses.

On the base of examined sets no relevant correlation was observed for individual time periods after introduction.

Table 16.: Financial performance indicators of ERP enterprise groups before introduction compared to time period after introduction.

ERP	ROA		ROS		ATO		ROE	
	BEF	10,55	BEF	4,34	BEF	2,65	BEF	17,61
	Asymp.	average	Asymp.	average	Asymp.	average	Asymp.	average
T+1	0,109	11,24	0,612	4,50	0,240	2,79	0,478	18,47
T+2	0,166	11,38	0,955	4,69	0,157	2,79	0,326	20,52
T+3	0,155	11,38	0,497	4,52	0,119	2,89	0,672	20,07
AFT	0,064	11,33	0,953	4,57	0,094	2,83	0,177	19,69

Analysing performance of enterprise circle formed by creating pairs of previous (ERP) enterprise groups was the other segment of examination. In case of NON

enterprises, ERP was not introduced, T0 time period was determined on the base of time, when matched enterprises that applied ERP introduced the system.

Table 17.: Compare performance indicators of NON enterprise groups before and after introduction. [Source: own work]

NON	ROA		ROS		ATO		ROE	
	BEF	12,11	BEF	5,14	BEF	2,46	BEF	20,24
	Asymp.	average	Asymp.	average	Asymp.	average	Asymp.	average
T+1	0,458	11,63	0,904	5,29	0,483	2,42	0,561	19,94
T+2	0,375	11,74	0,792	5,59	0,537	2,46	0,454	21,01
T+3	0,151	11,08	0,408	5,31	0,219	2,44	0,606	20,42
AFT	0,359	11,48	0,913	5,40	0,264	2,44	0,747	20,46

Under investigation of NON enterprise groups no statistical phenomenon was observed that could support unambiguous changes between data of either time periods. (Table 17.)

3.1.3. Matching with experiments in the United States

This dissertation concluded results that differ from experiments conducted in the United States in 2002 and before that time, which gave the scheme of present experiment and gave the following statements.

The study got along from the following hypothesis: Enterprises not introduce ERP systems have lower financial performance in the long run then enterprises applying ERP.

Results of statistical tests that analysed the hypothesis are presented in table 18. and in table 19. The last column of the table shows differences in financial performances before and after introduction of ERP. There is no significant difference between these two enterprises introduced ERP. Nevertheless, enterprises that are not applying ERP during the same time, the indexes decreased significantly: ROA ($t=2,239$; single-sided $P=0,014$), ROI ($t=2,397$; single-sided $P=0,010$) and ATO ($t=2,976$; single-sided $P=0,002$). In the same case ROS decreased perceptibly, but not significantly in the conventional meaning.

Table 18.: Mean values before and after (pre-medians and post-medians) introduction of ERP among enterprises applying ERP ($n=63$). [source: HUNTON et al. 2003]

Indicator	Pre	Post1	Post2	Post3	Pre vs. Post3
ROA	5,341 [4,637]	4,448 [5,031]	4,916d [4,715]	4,899 [4,692]	$t=0,731$; $P=0,468$
ROS	0,052 [0,050]	0,048 [0,045]	0,050 [0,053]	0,054 [0,054]	$t=0,351$; $P=0,727$
ATO	1,158 [1,041]	1,136 [1,105]	1,128 [1,091]	1,135 [1,051]	$t=1,016$; $P=0,314$
ROI	8,576 [8,614]	7,691 [8,957]	7,533 [8,411]	8,002 [8,395] ^c	$t=0,518$; $P=0,606$

Table 19.: Mean values before and after (premedians and post medians) introduction of ERP among enterprises not applying ERP ($n=63$). [source: HUNTON et al., 2003]

Indicators	Pre	Post1	Post2	Post3	Pre vs. Post3
ROA	5,455 [5,280]	3,946 [3,725]	3,571 [3,151]	3,720 [3,501]	$t=2,239; P=0,014$
ROS	0,053 [0,047]	0,045 [0,043]	0,042 [0,045]	0,047 [0,045]	$t=1,018; P=0,157$
ATO	1,156 [1,018]	1,057 [0,959]	1,061 [0,936]	1,066 [0,989]	$t=2,976; P=0,002$
ROI	8,498 [7,861]	5,804 [5,462]	4,649 [5,153]	5,457 [5,731]	$t=2,397; P=0,010$

The table also shows that performance of enterprises applying ERP diverged little from performance of enterprises not apply ERP. After three years introducing ERP, financial performance of enterprises are not applying ERP was significantly worse regarding ROA ($P<0,10$), and ROI ($P<0,05$) as well than ones applying ERP. Although ROS was stable among enterprises apply ERP while decreased among enterprises that do not apply ERP, difference was not significant. Moreover, in consideration of ATO values no significant difference was detected between enterprises apply ERP and ones that do not apply it, though ATO showed lower value – in case of enterprises do not apply ERP relative to enterprises apply it –after introduction then before it. Results in the table allow concluding that advantages come with the introduction of ERP only realized after a few years of introduction.

3.2. Results of ROI calculation

Values of ROI Calculator uploaded by the management of enterprises were investigated in 40 cases out of the basic population that stands up by 72 items. Hard ROI (hROI), i.e. index considers only direct profits showed efficient development – value bigger than one – in 28 cases in respect of three years. The same value in case of soft ROI (sROI) achieved 34.

Table 20. demonstrates enterprises, which financial indexes are recovered, in case of hard and soft ROI that have efficient values.

Table 20: Number of recovered financial indexes in case of the 40 returned ROI calculations. [Source: own work]

	ROA	ROS	ATO	ROE
Total	42	35	43	39
Calculator	31	22	30	25
hROI	23	19	19	19
sROI	27	21	24	23

Main cost items of the 40 examined projects introducing ERP are demonstrated at figure 3. The most determining segment of cost structure is the cost basis of the software, which achieved 44,8%. During introductions 21,7% was spent to hardware in average. The second biggest cost item, 28,2% was expended to guidance. Personnel (2,7%), education (2,5%) and other costs (0,2%) proved to be more insignificant.

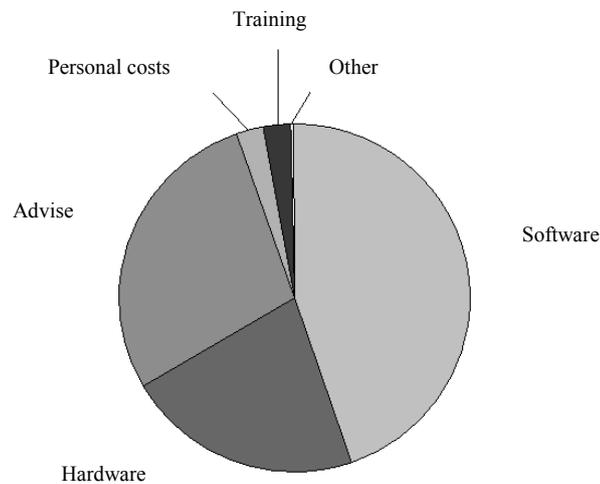


Figure 3.: Cost structures of ERP introduction participate in the test. [Source: own work]

A In case of distribution of direct profits (figure 4.) executives of enterprises laid the biggest emphasis on determining stock costs (41,0%) that is in line with recovery of ATO index, which statistically can be proved. Items of the second big group is connected to increasing turnover: increased middlemen orders (13,4%), increased turnover (12,2%), new source of incomes (8,7%), just as cross sale in terms of volume, but not content, and increasing distributive efficiency (4,6%) as well. Not in term of magnitude, but in term of total volume role of items belong to decreasing costs is efficient in formation of direct profits: reduced distributive costs (4,8%), reduced staff costs (4,8%) decreasing administrative costs (4,7%), reduced printing and postage (0,7%).

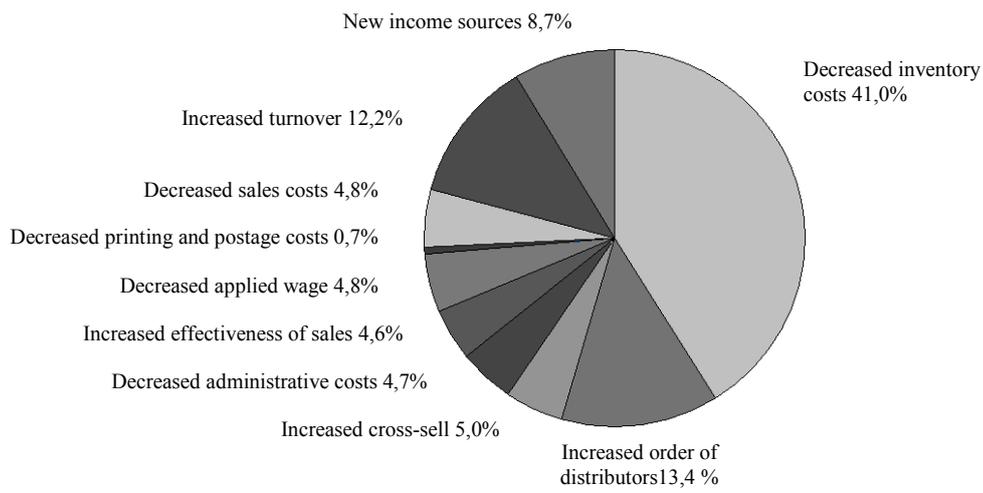


Figure 4. Distribution of direct profits at examined group

In regard of indirect costs the four examined groups were emphasized equally in calculations that were uploaded by executives of enterprises, and demonstrated at figure 5.

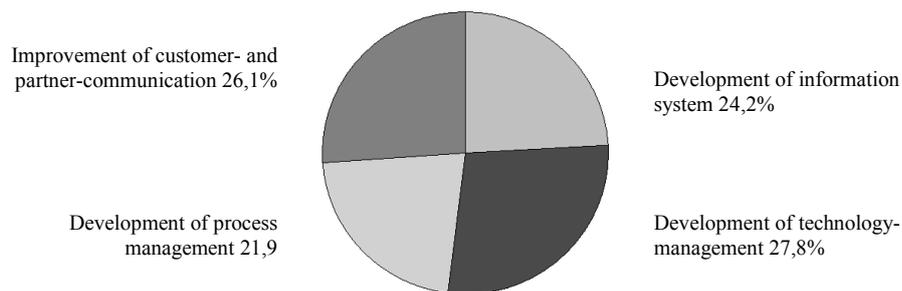


Figure 5.: Distribution indirect profits at examined group [Source: own work]

Profits that can be deducted from development of information system were quantified firstly in the course of examining indirect profits. Figure 6. shows that one quarter of this profit category comes from management costs recovery (25,8%). After this, roles of certain items can be considered homogenous in the total profit category. However, in spite of light differences the following order can be set out: cost of disorganized employees (9,8%), reduced inventory (8,9%), reduced administrative costs (8,3%), reduced training costs (8,3%), upscale in productivity of employees (8,2%), reduced product rework (7,7%), reduced communication costs (6,1%), reduced costs of inventory management (6,1%), reduced marketing costs (5,9%), reduced time for market monitoring (5,0%).

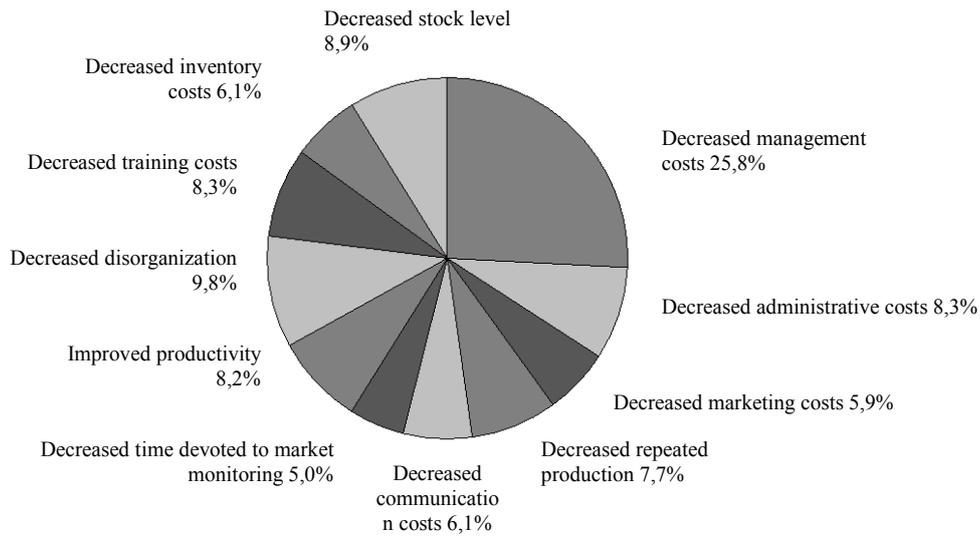


Figure 6.: Distribution of profits derived from development of information system. [Source: own work]

Figure 7 demonstrates distribution of indirect profits that can be identified by development of technology management. Considering volume of each item this category can be regard as a double level profit category. On the first level reducing management costs (32,4%), and profit item derived from reducing integration costs can be identified. Items of the second level contribute to increasing enterprise efficiency to the same extent; within technology management they distributes as the following measures shows: reduced system maintenance costs (16,0%), reduced development costs (13,7%) and reduced infrastructure costs (13,4%).

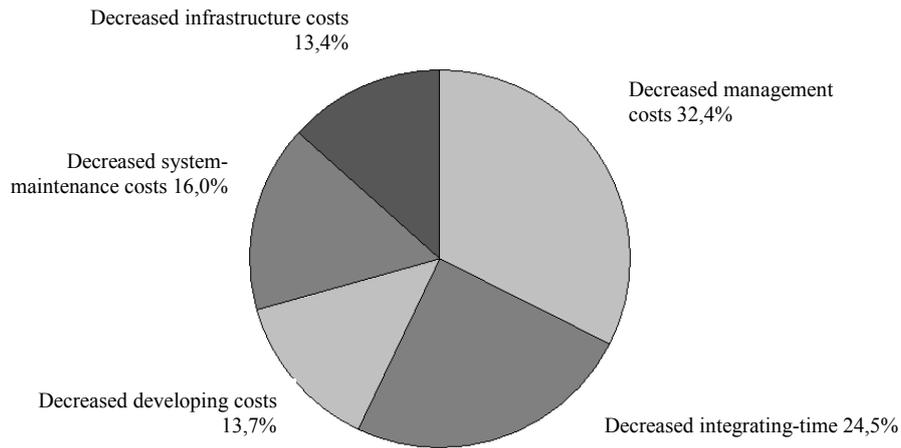


Figure 7.: Distribution of profits derived from development of technology management.
 [Source: own work]

Figure 8 demonstrates profits experienced on the field of process management and its distribution relative to each other. Reduced management costs (35,4%) were quantified as the biggest item in this profit category by executives of enterprises as well. This is followed by two items that have identical volumes: reduced administrative costs (19,3%) and reduced communication costs (15,7%). In the order of magnitude in the field of the third level three cost reducing items can be found: reduced costs of errors and omissions (10,2%), reduced costs of sales (9,8%), reduced training costs (9,6%).

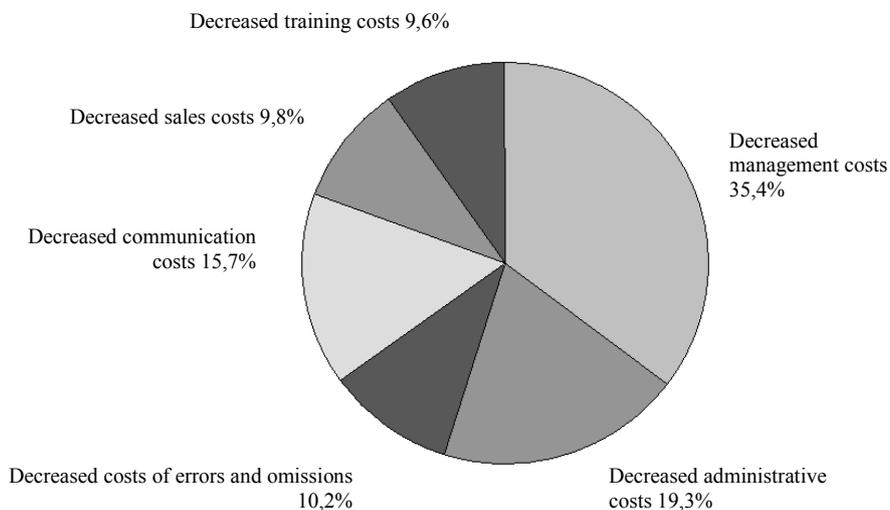


Figure 8.: Distribution of profits derived from development of process management.
 [Source: own work]

The last fixed profit item showed salient value in case of reduced logistic costs (28,0%). Remaining profit items demonstrate rates derived from recovery of customer and partner communications joined with indirect profit items at figure 9. Considerable items are reduced communication costs (16,5%), reduced stockpiling costs (13,5%) and reduced time for market monitoring (12,8%). The third level contains reduced product rework (10,8%), reduced customer care costs (9,7%), and reduced penalty (8,7%).

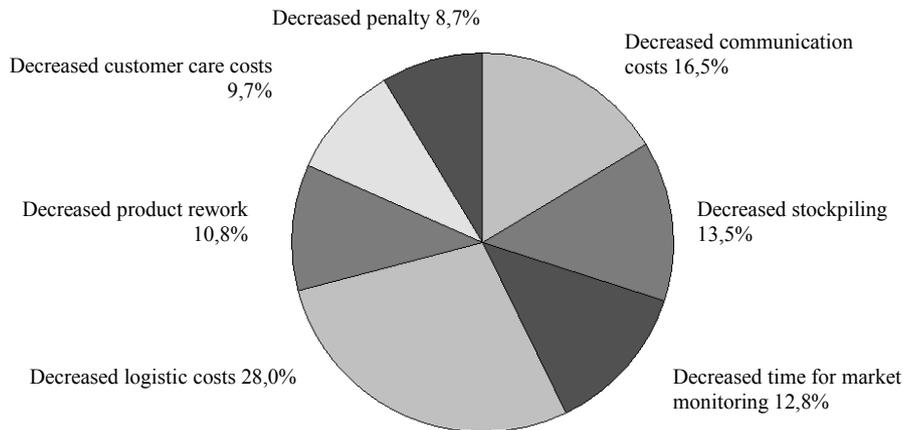


Figure 9.: Distribution of profits derived from recovery customer and partner communication. [Source: own work]

Figure 10 demonstrates numbers of recovered items in respect of financial indexes in the whole basic population. Column signed as 'sum' refers to ERP enterprise group that has 72 items. Recovery can be assessed in 42 cases regarding ROA, while same figures regarding ROS, ATO and ROE were commonly 35,41 and 39. In every group of columns the second one got the 'calc' sign. They are the part of the population constituted by the 40 enterprises that returned evaluable ROI calculations. In case of these enterprises recovery of financial enterprises is summarized hereinafter: ROA in 31, ROS in 22, ATO in 30, and ROE in 25 cases showed reversed values.

In case of 41 enterprises that take part in ROI calculation, hard ROI, which contains only direct profits, and soft ROI, which contains indirect profits were calculated as well. Last two items of the column-group show number of cases, when the given ROI shows efficient return, and figures of financial indexes recovered as well, i.e. those overlapped cases, when economic calculation of investments made by enterprise management gives positive results and recovered indexes derived from accountancy appears as well.

Proportion of direct and indirect profits compared to each other was 1,64 in the examined sample.

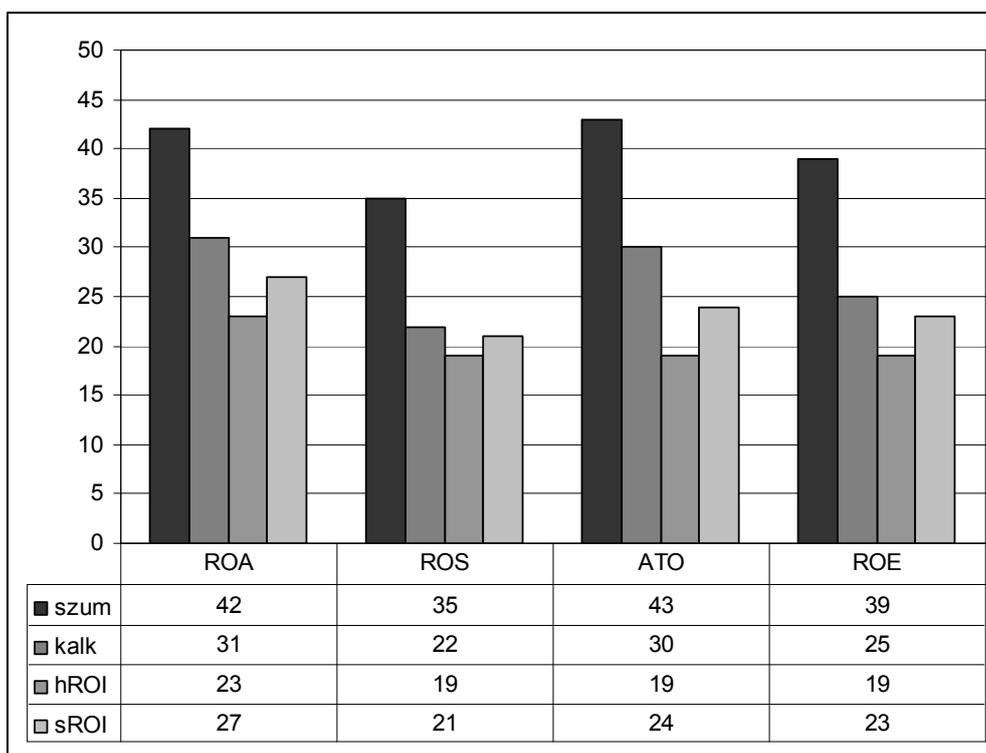


Figure 10.: Number of recovered financial indexes in case of 40 returned ROI calculations
 [Source: own work]

Proportion of enterprises that take part in the calculation (40) and possess recovering financial indexes to basic population (72) can be described by the following ratio: ROA 31/42, ROS 22/35, ATO 30/43 and ROE 25/39. Figure 11. describes these values in percentages. Financial indexes recovered by 73,8%, 62,9%, 69,8% and 64,1% in average in case of enterprises participated in the calculation. Recovery tendency, which is the mean of averages, is 67,6%. The same value regarding the basic population (72 items) is 55,2%. Namely, enterprises that show more willingness to calculation has more beneficial changes in financial indexes, i.e. invert it, better financial achievements resulted bigger inclination to fill calculation forms in examined sample. Naturally, enterprises gladly evaluate an introduction, which thought to be successful by the enterprise itself than a project has doubtful success.

Recovery of financial indexes in case of 'hard' ROI by comparison with enterprises takes part in the calculation and shows recovery tendency can be described by the following ratio: ROA 23/31; ROS 19/22, ATO 19/30 and ROE 19/25 that data in percentage is demonstrated at figure 14. 'Hard' ROI counted by the calculator indicates recovery of financial indexes by 74,2%, 86,4% 63,3% and 76,0% accuracy. In case of 'soft' ROI the same data achieve 87,1%, 95,5%, 80,0% and 92,0%.

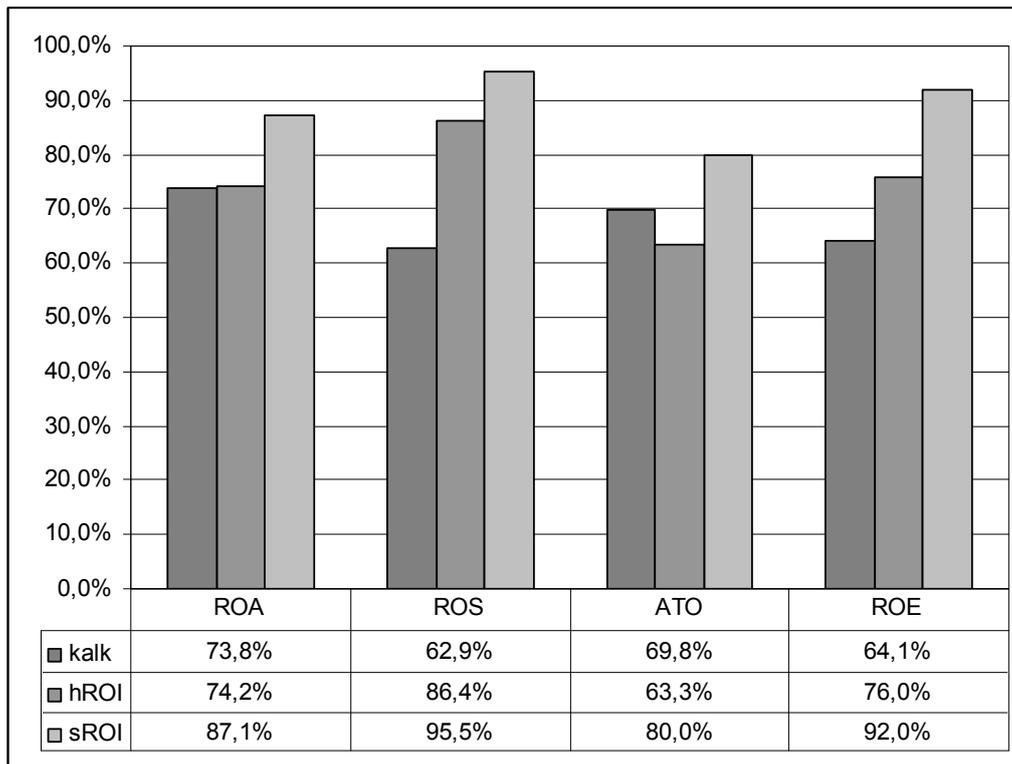


Figure11.: Proportion of financial indexes to the basic population('calc' case) and population participate in calculation (hROI and sROI case). [Source: own work]

3.3. New Scientific Results

1.) All four financial performance indicators (ROA, ROS, ATO, ROE) have showed recovery in case of enterprises introduced ERP, moreover, in case of ROA and ATO the hypothesis was verified by statistically, non-parametric tests as well.

(The first experimental hypothesis was defined as enterprises introduced ERP systems have an increasing financial performance in comparison with their pervious performance. Statistically defined hereinafter: H1 Financial performance of enterprises introduced ERP systems remained unchanged in the long run by comparison themselves.)

2.) In case of enterprises not introduced ERP systems discrepancy between certain time periods can not be confirmed statistically. (H2 Financial performance of enterprises not introduced ERP systems remained unchanged in the long run by comparison themselves.)

3.) In the framework of the dissertation profit items of integrated enterprise management information system were collected broadly and inserted into a complex evaluation system.

4.) As a result of the research-innovation activity of the dissertation a complex analysing-evaluating system was created that can evaluate enterprise information systems from an economic point of view. By analysing 40 cases, proportion and internal structure of direct and indirect profits gained on projects introduced ERP systems was determined with ROI calculation model.

ERP ROI calculator: it takes cost items of ERP project in modular proportion and analyse them in numeral and graphical form. Profit module widely examine possible profits of the given ERP project and enable analysing module to make calculations regarding hard and soft ROI as well. Thus, it appreciably approximates real management importance of ERP projects.

5.) By means of ROI calculator positive correlation was pointed out between financial performance indicators of enterprises introduced ERP and ROI calculations of the calculator.

6.) By means of demonstrated model, economic evaluation of projects aimed to introduce ERP systems become possible, moreover, it was derived through this model that is expedient to figure out the so-called soft ROI value in case of investment-economic examinations and use it in further analyses.

7.) Financial performance indicators and model based economic examinations are expedient to be integrated and displayed on a common coherent system.

4. CONCLUSIONS AND SUGGESTIONS

4.1. Conclusions

On the base of the examined sample regarding financial performance indicators in case of enterprises introduced management information systems statistically assessable recovery was observed.

It follows that remarkable correlations can be explored by extending examinations and increasing their perceptions. This can explore features of certain sectors and system specifics as well.

At the same time financial performance indicators per se are insufficient to set advantages of a management information system in money. Flux of external and internal processes disables to trace back changing values of these indexes in one factor. However, to aside from these examinations are not expedient, while effect of introduce management information appears in these indexes too.

Out of the sought 72 enterprises, 40 uploaded ERP ROI Tool Kit model, as MIS return evaluating system, in evaluable manner. Relative high proportion of returned forms show that executives of enterprises are interested in returns of money spent on management information systems, and how their profits can be figured.

Executives of enterprises had preconceptions, or preliminary opinions about utility, efficiency and return of introduced management information system. In the same time results of the calculator were alongside taken interest. The methodology got several recognition and several criticisms. Nevertheless, it was perceptible that systems economic assessment became definable with the help of the model, it gave opinion, adjudication, and in certain cases it induced decision in everybody.

Application of models that were sent out in several cases did not finish at point when values of examined time period were uploaded, but data of additional years were written and are getting written. Each index was followed and values were evaluated continuously. The following step is, values of each line are specified or can be specified in target values.

Nevertheless, we can not apart from personality, expectations and experiences of executives filling the form. These items notably alter calculations of the calculator. Increasing the severity of methodology and guidelines is expedient; however, at this point development and conductions of sector specifications can not be sidestepped.

Financial indexes retrievable from accuracy and weaknesses, errors of calculator can be decreased in joint application, and its strengths can be preserved and developed. Integration of these two approaches means an

essential step in the evaluating methodology of management information systems. It gives the opportunity to plan return of investment beyond evaluation of the past by determining target values. However, enterprises and managing organisations are functionally bent with these systems, and in a good possible case it gives a full map about business processes. Hence, by widening, integrating and developing plan-fact functions of the method based on economical evaluation of management information system, and by using results of other disciplines, it can reach the margin to evaluate the whole functionality of enterprises. Moreover it would apply BSC (Balanced Scorecard), a performance management tool to use financial measures to inform the strategic control of the enterprise.

4.2. Further exercises and research, innovation possibilities

4.2.1. Additional tasks and possibilities to examine performance indicators

Increased number of examined items is required in further analysis. This will be easier compared to the beginnings, as number of projects that aim to introduce ERP systems is appreciably increased. Vendor enterprises have an opened mind about small and medium sized enterprises, and agriculture, whereas merchandise possibilities are notably decreased. This basically increases the base to take samples. Penetration is an advance in terms of utilise experimental results. Enterprises have more profound knowledge about ERPs, thus they can define more exact expectations, and get system more appropriate to their situation. By expanded knowledge, heavier economic expectations for ERP systems can be defined, and it can compete with other resources. As a result of it, development of a technique and/or method that can manage it in bulk is essential.

Increasing the number of items make possible to analyse different sectors of the economy. That make possible to analyse results of ERP systems in certain sectors, not just performance of enterprises. Appropriately planned and managed examination can compare certain ERPs on the base of performance reported at enterprises introduced the system.

Expending indexes, considering features of a sector, and separating other effects is expedient. Further analyse can be oriented to discover connection between size, financial health of an enterprise and the successfulness of ERP system.

4.2.2. Tasks and possibilities to improve ROI calculator

The following standpoints are to be followed to improve ERP ROI Tool Kit model:

- On cost side hardly identifiable and quantifiable items have to be defined and integrated in the model
- Efforts have to be made to use more quantifiable, and better established techniques to develop income side (statistic methods, benchmarking, development of reference databases)
- Generally accepted indexes have to be integrated in analysing module, methods have to be developed that have special features and can be used for evaluating ERP systems.
- Development of evaluating module aims to develop a complex evaluating system that is able to information processing and display risk factors of projects that introduce management information systems.

4.2.3. Integration of the two methods

Interface to receive data required for calculation of financial performance indicators have to be formed in the ERP ROI Tool Kit model. Joint display and evaluation of results obtained by the two methods can significantly increase reliability and applicability of the whole evaluation process.

To form reference databases from already existed data is exhibited to match and evaluate results produced by the calculator. By developing an appropriate base to take samples, and by applying an appropriate methodology, the evaluating system can be adapted to conclude deliberate statements.

Publications

a) Scientific publications

Book items in foreign language:

Book items in Hungarian language:

Szűcs István, Farkasné Fekete Mária et al: Hatékonyság a mezőgazdaságban (270-276 p.), Agroiinform Kiadó Budapest 2008, ISBN 978-963-502-889-4

a) Scientific reviews

In English:

- 1) Zsigmond Gábor Szalay: Appriaisal of Investments int he Farm Management Information Systems. In Annals of the Polish Association of Agricultural and Agribusiness Economists (SERiA). 2007. Tom IX. (487-490 p.) ISSN 1508-3535
- 2) Zsigmond Gábor Szalay: Especial Costs of the Farm Management Information Systems. In Annals of the Polish Association of Agricultural and Agribusiness Economists (SERiA). 2007. Tom IX. (491-494 p.) ISSN 1508-3535

In Hungarian:

- 3) Szalay Zsigmond Gábor: A menedzsment információs rendszerek költség-haszon elemzése. In Szent István Bulletin. 2008. (Part II 653-664 p.) ISSN 1586-4502

c) Conference reviews

In English:

- 4) Zsigmond Gábor Szalay, Balázs Györök, Alex Arutyunjan: Virtual Decision at Virtual Companies. In II. International Conference of Ph.D Students; Miskolc 1999. ISBN 963 661 374 5 p. 269-274.
- 5) Balázs Györök, Zsigmond Gábor Szalay, Balázs Gyenge: Dinamic Simulation of Pig Production. In II. International Conference of Ph.D Students; Miskolc 1999. ISBN 963 661 374 5 p. 91-96.
- 6) Szalay Zsigmond Gábor, Györök Balázs: Information systems for small-scale farms. In Economic and Managerial Aspects of Sustainable Develpoment of Agriculture, Nitra 2001, ISBN 80-7137-868-2 p. 801-804

- 7) Szalay Zsigmond Gábor: The Overview The Business Games. In 1st International Conference for Young Researchers, Gödöllő 2001, ISBN 963 9256 50 1 p. 321-323
- 8) Szalay Zsigmond Gábor, Matisz János: E-business - Overwiev Of Hungary Taking Part In The E-World. In Economic And Management Of Enterprises In The Process Of Globalisation, Nitra 2002. ISBN 80-8069-030-8

In Hungarian:

- 9) Dr. Kovács Árpád Endre, Kovács Attila Zsolt, Szalay Zsigmond Gábor: Vezetői döntéstámogató rendszer fejlesztése a malomipar számára. In VI. Agrárökonomiai Tudományos Napok. Gyöngyös, 1997.
- 10) Szalay Zsigmond Gábor, Arutyunjan Alex, Kovács Attila :Malomipari tulajdonosi és vezetői információs rendszer - a Malinfo. In Georgikon Napok Keszthely 1999.
- 11) Arutyunjan Alex, Szalay Zsigmond Gábor: A német és s az amerikai jelzáloghitelezési modell összehasonlítása. In Georgikon Napok Keszthely 1999.
- 12) Szalay Zsigmond Gábor, Györök Balázs, Arutyunjan Alex: Tulajdonosi és Vezetői Információs Rendszer fejlesztésének tapasztalatai egy malomipari vállalat példáján. In Informatikai kutatások, fejlesztések és alkalmazások az agrárgazdaságban '99, Debrecen 1999. Előadás p. 307-312
- 13) Kovács Attila, Györök Balázs, Szalay Zsigmond Gábor: Döntéstámogató rendszer legeltetésre alapozott állattenyésztési kisvállalkozások részére. In Informatikai kutatások, fejlesztések és alkalmazások az agrárgazdaságban '99, Debrecen 1999. Előadás p. 302-306
- 14) Arutyunjan Alex, Kovács Árpád Endre, Szalay Zsigmond Gábor: Bankkártya forgalom optimalizálása. In Informatikai kutatások, fejlesztések és alkalmazások az agrárgazdaságban '99, Debrecen 1999. Előadás p. 87-91
- 15) Györök Balázs, Kovács Árpád Endre, Szalay Zsigmond Gábor: A sertéstartás dinamikus, objektumorientált szimulációs modellje. In Informatikai kutatások, fejlesztések és alkalmazások az agrárgazdaságban '99, Debrecen 1999. Előadás p. 359-362
- 16) Kovács Árpád Endre, Szalay Zsigmond Gábor, Szilasi Beatrix: Kis- és középvállalkozások információs rendszerének fejlesztése. In Informatikai kutatások, fejlesztések és alkalmazások az agrárgazdaságban '99, Debrecen 1999. Előadás p. 270-277
- 17) Kacz Károly, Szalay Gábor Zsigmond (2000): A mezőgazdasági üzemstruktúra vizsgálata a Nyugat-Pannónia Eurégióban VISION-2000

III., Gödöllő, 2000. november 10., anyag konferencia kiadványban (II. kötet) p. 309-312.

- 18) Szalay Zsigmond Gábor, Kacz Károly (2004): A vállalati információs rendszerek lekötési költségei Within the European Union (WEU) nemzetközi konferencia, Mosonmagyaróvár, 2004. május 6-7., összefoglaló 71. p., teljes előadás CD kiadványon

d) Specialist book

- 19) Dr. Kovács Árpád Endre, Szalay Zsigmond Gábor, Szilasi Beatrix: A Projekt menedzsment lényege és tervezése 3.5 fejezet p. 17. In Gazdálkodók kézikönyve, B, RAABE Kiadó 1999. december

f) Other publications

Course book
In Hungarian

- 20) Klárné Bartha Éva, Kovács Árpád Endre, Molnár Attila, Szalay Zsigmond Gábor (szerk.: Kovács Árpád Endre): Vállalatirányítási Információs Rendszerek. Szent István Egyetem, Gödöllő. 2003.
21) Klárné Bartha Éva, Kovács Árpád Endrem, Molnár Attila, Szalay Zsigmond Gábor (szerk.: Kovács Árpád Endre): Információgazálkodás
22) Egyetemi jegyzet. Szent István Egyetem, Gödöllő 2005.
23) Klárné Bartha Éva, Kovács Árpád Endre, Szalay Zsigmond Gábor (szerk.: Kovács Árpád Endre): Adatbázis-kezelés és Vállaltirányítási Információs Rendszerek, Egyetemi jegyzet. Szent István Egyetem, Gödöllő 2006.

Research project

NKFP-2004-4/014. The conditions of the correction of the efficiency in the utilisation of the resources of the agriculture: optima and practical applications.
Head of the project: Dr. István Szűcs DSc.
Team of the Information Management
Head of the team: Dr. Csaba Székely DSc.
Members of the team: Balázs Györök, Attila Kovács, István Pető, Zsigmond Gábor Szalay, Endre Zerényi

Citations: -

Participation of research projects

2002-2004 MEH SZT-2002-EG-2 Benchmarking research of the realization of the electronic democracy in European Union.

NKFP-2004-4/014. The conditions of the correction of the efficiency in the utilisation of the resources of the agriculture: optima and practical applications.

Head of the project: Dr. István Szűcs DSc.

Team of the Information Management

Head of the team: Dr. Csaba Székely DSc.