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LEVELS OF INNOVATION OF BUSINESS INFORMATION SYSTEMS

Abstract

The main scope of this article deals with business information system and their innovation. On the base of analogy manufacturing technology and with using of methodology ITIL and CobiT is suggest way of evaluation and innovation of the business information systems for each of their partial areas. These areas are functionality of information system, SW decision support, data, controlling of IT, processes in IT, peoples in IT, information and communication technology. There is a rule being defined for each innovation area in a seven-step scale, and with this approach the innovation can be reached for each single area and in different levels. Innovation levels are part of suggested methodology, which offers evaluation and innovation of business information system.

1. INFORMATION SYSTEMS AND INNOVATION

Similarly as a goods or production cycle, the information system is developing. His structure is quite different from physical product, where is very simple to imagine component levels of innovation. From this point of view, information system looks like collection of more products (very often unphysical), more partials units, because they are consists of separate parts.

On the next point is seen, why is suitable to engage in this topic:

1. Business information systems as a unit are from long view to innovation new element, which come in last thirty years. From this reason there was not necessary to take care about it sooner. In the present bibliography, there are not presented any gettable cases or methodology for innovation of business information systems. The attention was focus on implementation and selection of information system.
2. The innovation has been part of life cycle of information systems, but only as a jump innovation. They were used for radical change of information system, not for partial development of existing IS. The information systems are already implemented in majority of large companies. There are implemented and now comes time for their partial innovation and development.
3. Implementation of information systems took great investment, but in the present is put emphasis to saving and returnable of invested money.

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4. The newest trend, which is s stressed by authors, is need of innovation of IS (information and communication technology, or ERP). Now a day it is not only about choosing and implementation of information system and his supplier. Is necessary to find out new ways of innovation of ERP systems, or his main parts, connected with innovation of business processes. Is possible to innovate business processes without connection to IS/IC tools, but during realization is necessary to check practical viability.

2. ASSUMPTIONS FOR SUGGESTION OF INNOVATION BUSINESS IS

Life cycle of ERP

Life cycle of ERP system, is from customer's point of view, consists of four basic periods, and is showed on picture No. 1.

1. Selection – finding suitable solution for company, according to functionality and price
2. Implementation – implementation of ERP system, adaptation a changing of company process.
3. Exploitation – productive phase of ERP system
4. Innovation, upgrade, remove – phase of thinking about change

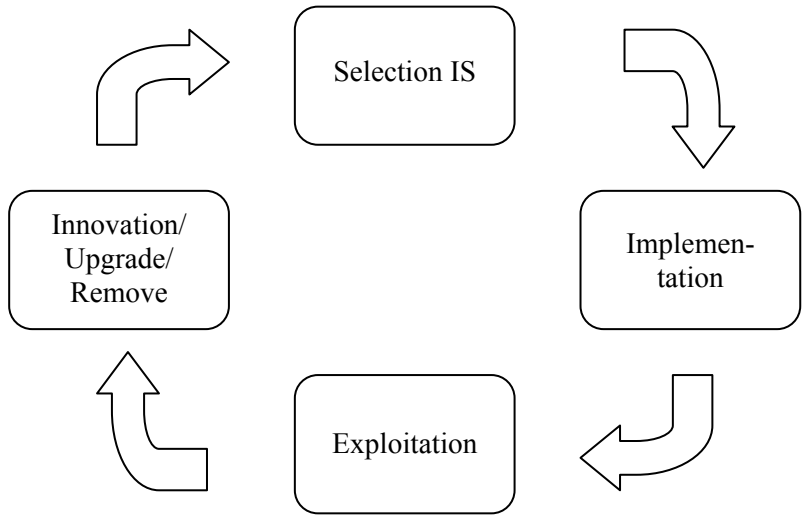

Fig.1. Life cycle of ERP system [3]

Each period of life cycle has defined the beginning and the end. In some cases can be discussed this boundary, because every customer and provider have his own point of view. But generally can be said, that end of period connected with payment to supplier.

Works and scientist articles, which have been published so far, are focus on the first three periods of life cycle of information system. But there are not published articles about four periods till now. There are several reasons to go in for:

1. There was not reason to innovate business information systems, because the majority of investments were focus on implementation of ERP.
2. There was not reason to invest, from point of view of companies, is investment to ERP enough one in five years, but the suppliers have different opinion.
3. Development of investment to ERP was reduced

Perspective of customer vs. supplier of enterprise information system

At the beginning is necessary to split the perspective to innovation of business information system to two parts:

- perspective of company (customer),
- perspective of supplier (we will suppose, that supplier is producer of ERP too).

Company wants to gain such quality services for invested money, as is possible. It means, with minimal costs and if it is possible, for ever. Behaviour of company is displayed on figure No0, on an innovation of information system. Companies usually suppose that after big beginning investment "it will work forever", and they will not need another investment. Unfortunately, it is not true. Generally it could means, that companies are forced to innovation from the reason of finishing support for current IS from side of supplier.

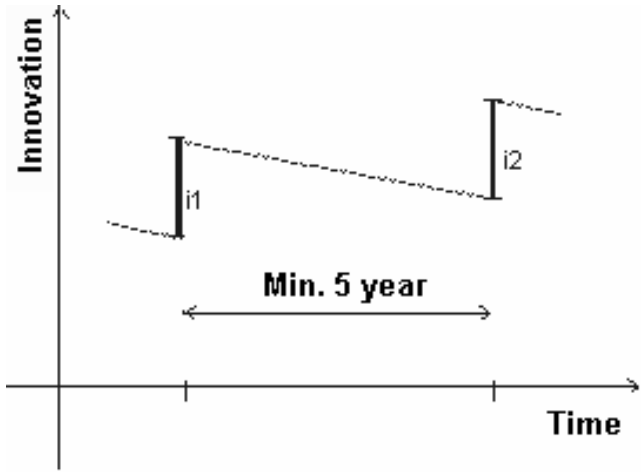

Fig.2. Company view to innovation of IS

On the other hand, objective of supplier is creating new versions of IS, new or improve modules and of course sold it to customers. Behaviour of supplier is displayed on figure No0.

Suppliers' needs to create new version of there is, because it is their "core business". And this needs to sell to the customers.

For supplier is version of IS out of date it time of release, and he is preparing new one. Period between releases of new versions is about 18 to 24 month. As a new version we can call change between versions 2.0 to 3.0. Of course in the time between releases, the system is partly innovated and corrected. This we can call as a partly modification, which mean correction or change from the reason of legislative. This modification we can find in versions 2.1, 2.2 etc.

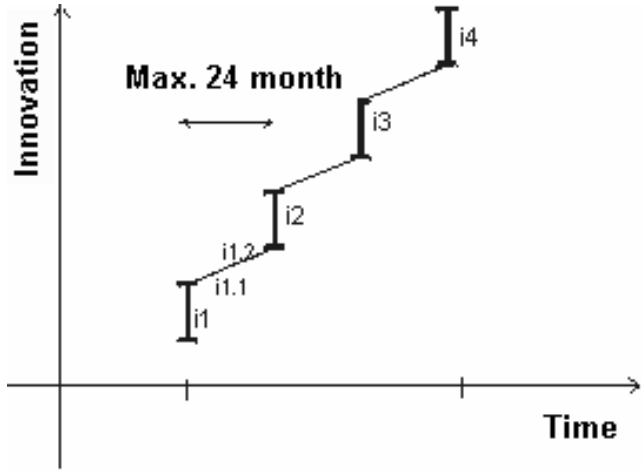

Fig.3. Supplier view to innovation of IS

From the reasons, what were mentioned before as behaviour of customers and suppliers, there is different view of them to innovation of information system. Supplier want's to implement each new version, on the other hand, customer is satisfied with current IS and he is afraid about new implementation. The reason for change could be finish of support for current IS version.

The second conflict of interests is in the price. Supplier want's to sell everything for the best price, customer want's best information system with low price.

For exploration innovation of information system from point of view customer and supplier I have decided, that is not possible to fill in all levels of innovation, as they were defined by prof. Valenta [4]. For information systems is possible to reduce innovation levels to 6 or 7 levels.

3. LEVELS OF INNOVATION OF BUSINESS INFORMATION SYSTEMS

Based on separation of innovation, customers and suppliers, I have decided to focus on innovation from customers' point of view, because of disunity of both ways. The companies are under big pressure now a day, and from this reason I decided to create new levels of innovation of business information systems from customers' point of view.

New suggested approach for controlling of innovation of information systems is disengaged from view to innovation as a whole unit, what was prof. Valenta approach, when the level of innovation is strictly connected, what will be change on technologic side and what will preserve.

Using following knowledge:

- Prof. Valenta innovation levels for manufacturing (10 levels),
- Capability Maturity Model – describe a framework of five stages of evolution or levels of capability or process maturity,
- CobiT – methodology for controlling information and communication technology,

- process approach

offer the way for evaluation company in partial areas of controlling informatics in company.

These areas are:

1. functionality of information system,
2. SW decision support,
3. data,
4. controlling of IT,
5. processes in IT,
6. peoples in IT,
7. information technology,
8. communication technology.

There is a rule being defined for each innovation area in a seven-step scale. As an inspiration was used structure of CobiT methodology.

- Levels -1 and 0 came from conception of Prof. Valenta methodology, where information system can be in a condition of degeneration, or can be only maintaining on a current level.
- Ad-hoc approach is defined by partial maintain of IS functionality, but this approach came in as a reaction to requirements or problems. On this level is most important technical manager knowledge.
- Running reactive approach expands the functionality of current IS by continuous work on requirements of users, or technical manager. But it is not systematic controlling.
- Proactive approach of controlling IS based on IT strategy in company. It assume, that are described all of IT processes and exist strategy and plan of maintenance.
- Proactive approach with evaluation extends preceding level about measuring of reached results, and based on them is corrected IT controlling. This level assumes controlled and measurable IT processes and controlling based on IT strategy, IT plan and metrics.
- Radical change is defined as a quite new conception of functionality IS. This level assumes ASP or outsourcing and also optimization of IT processes.

These new defined levels and approach of this methodology is quite different from previous. As against to prof. Valenta, each level is not directly connected with change, conversely each area is measure separately. As a result is evaluation, which denote situation in all areas regarding to information system in company and suggest innovation, which can be made in each area of IS on different level.

Tab.1. Levels of innovation of business information systems

Level of innova-tion	Basic characte-ristic	Functionality of IS	SW decision support	Data	Controlling of IT	Processes in IT	Peoples in IT	Information technology	Communi-cation technology
-1	Degenera-tion	losing functionality	non	paper binder	not controlled	blank	not trained	obsolescence and wear down	non
0	Regenera-tion	maintenance of existing functionality	reports	binder + static tally	based on internal needs	described only business processes	running maintenance of qualification	maintenance of HW	isolated PC
1	ad-hoc approach	partial deve-lopment of functionality of current IS	ad-hoc SW support	type of Excel tally	accidentally as an reaction on users requests	described as an impact of other project	unsystematic training	maintenance of HW by own sources	connected PC and terminals
2	running reactive approach	development of functionality of current IS	specifically targeted queries and reports	database	running by the users requests	described basic IT processes	basic increasing of qualification	purchase of new HW components	intranet
3	proactive approach	upgrade of current IS	business intelligence	share database	based on IT strategy	described all of IT processes	increasing of qualification based on plan	purchase based on strategy	internet and extranet
4	proactive approach with evaluation	substitution of current IS to new with identical conception	business intelligence and concept of „cockpit“ type	data warehouse	based on IT strategy, IT plan and metrics	controlled and measurable IT processes	targeted training with connection to asset for company	purchase based on strategy with connection to assets	portals
5	radical change	IS with quite new conception	competitive intelligence	knowledge management	ASP, outsourcing	optimizatio n of IT processes	radical retraining	outsourcing	mobile device

Representation of information system situation could be made on spider diagram. Diagram is displayed on figure No. 4. This graph is split to three parts, similarly to table No0

1. Support of IS to customer
2. Controlling of IT.
3. Information a communication technology.

Firs part goes in for evaluation of company IS from the support to customer view. It include columns Functionality of IS, SW decision support and Data from table No0, because for customer and user of IS are data which IS offers very important.

Second part goes for controlling of IT and includes columns Controlling of IT, Processes in IT and Peoples in IT. This part is focus on controlling of IT, IT process definition and off course user training.

Third part goes for information a communication technology, and include last two columns from table No0.

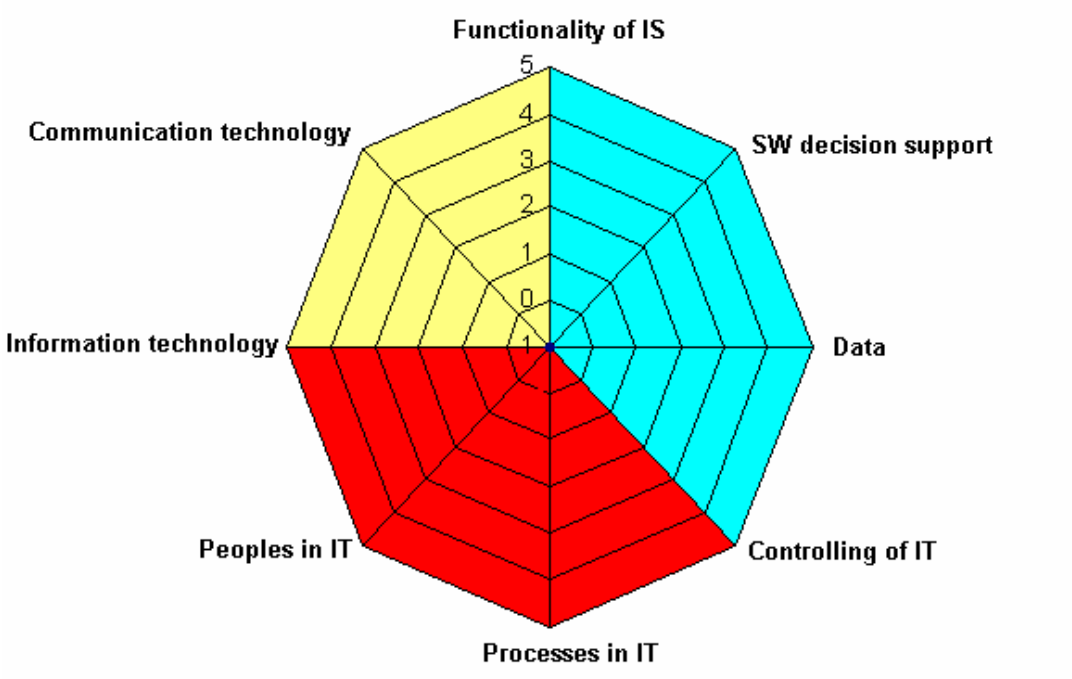

Fig.4. Spider diagram

New suggested approach for controlling of innovation of information systems is disengaged from view to innovation as a whole unit, when the level of innovation is strictly connected, what will be change on technologic side and what will preserve. The methodology offer the way for evaluation company in partial areas of controlling informatics in company. This evaluation can by used as and support for management decision making about investment to IS and connected business processes.

Next aim of this methodology is suggestion about innovation of IS, which can be made in each area of IS on different level.

4. VERIFICATION OF METHODOLOGY OF INNOVATION BUSINESS INFORMATION SYSTEMS

New methodology designed and described in details in above chapters was necessary to verify theoretically and also practically.

The practical verification of methodology was undertaken in a form of surveys investigation in selected companies. Those companies were enquired for status of their information systems before innovation and after the implementation of the new systems.

The theoretical verification of methodology was undertaken based on building of statistical models that defined relationship among the particular areas of designed methodology. The evaluation of these models analysed possibilities if the innovation in one area can have influence on the other areas of the information system. In case that the positive answer will be identified then the question will be how strong such influence will be.

4.1. The practical verification of methodology

The special sample of companies was prepared for the practical verification of the designed methodology. The companies selected into this sample have following common feature – they all had decided for the innovation of used information systems or for the implementation of the new information systems recently. The further criterion for the selection of analysed companies was their financial stability and strong financial background. After careful investigation there was one more criterion added and the single information system software package was selected – system by SAP company. Under the SAP term there are understood following systems and product - SAP R/3, mySAP Business Suite a také mySAP All-in-One.

The important criterion was also the branch of companies. The emphasis was put on the coverage of the whole spectrum according to their market share within the Czech national economy. The structure of branches corresponds to OKEČ system.

Upon above mentioned criteria there have been 13 companies selected. They all fulfilled defined criteria or they were interesting with their activities (for example the statutory city).

There were surveys undertaken in companies. The form was either the survey or interview with the managers, IT director and consultants of the implemented systems. The question concerned the status and the description of the information systems before innovation and analogically also for the current information systems.

Tab.2. Set of companies for verification of methodology

Company	Branch	No. of employee	Type of company	Owner	Reason for innovation
R1	industry – food	180	join stock	foreign	leaving own development
R2	public	1600	city	Czech	effort of gaining better information for controlling
R3	Public transportation	1160	join stock	Czech	suggestion of owner
R4	industry - engineering	167	join stock	Czech	costs of maintenance of own solution

R5	industry – glass	245	join stock	foreign	suggestion of owner
R6	wholesale - building material	525	join stock	foreign	troubles with legislation, needs of controlling
R7	wholesale - pottery	250	join stock	foreign	costs of maintenance of own solution, vision of ERP solution
R8	industry - food	112	join stock	Czech	support of controlling in ERP system
R9	industry - clothing	436	join stock	foreign	change of owner, unification of ERP system in company
R10	wholesale – fuel	191	join stock	Czech	unification of ERP system in holding
R11	industry – cable	189	join stock	foreign	change of owner, unification of ERP system in company
R12	services - IT	200	join stock	foreign	unification of ERP system
R13	wholesale	143	join stock	foreign	function and technologic datedness

The questions were oriented on the reasons used in companies for innovation. The main reasons for IS innovation were:

1. functional and technological obsolescence of IS
2. high cost of the current IS maintenance
3. fragmentation of particular parts of information systems and lack of getting information over all parts of IS
4. changes of companies owners and adaptation of IS to corporate strategy, e.g. taking over of IS from the mother company

Tab.3. Audit of the information systems in analysed companies

	Functio-nality of IS	SW decision support	Data	Contro-lling of IT	Proce-sses in IT	Peoples in IT	Information technology	Communi-cation technology
R1	0	0	1	1	0	1	0	0
R1	2	2	3	2	3	1	3	1
R2	1	0	1	2	-1	1	2	1
R2	2	3	4	3	3	2	4	3
R3	-1	0	1	1	-1	0	1	2
R3	1	3	4	1	2	0	2	3
R4	0	0	1	-1	-1	-1	0	1
R4	0	2	2	-1	1	-1	0	1

R5	0	1	3	0	1	0	1	1
R5	1	2	3	2	2	1	2	1
R6	0	0	2	2	0	1	0	1
R6	2	2	3	3	3	2	3	1
R7	1	1	2	2	2	2	2	1
R7	2	2	3	3	3	4	3	1
R8	0	0	2	1	-1	0	1	1
R8	2	2	3	3	3	2	3	1
R9	1	1	3	2	2	2	1	1
R9	2	2	3	3	3	3	3	3
R10	1	1	3	2	2	3	3	3
R10	3	3	4	3	3	4	4	3
R11	1	1	3	1	0	0	1	1
R11	2	2	3	2	2	2	2	3
R12	1	1	3	2	2	3	3	3
R12	2	3	3	3	3	4	4	3
R13	1	2	3	1	-1	0	1	1
R13	1	1	3	2	2	2	1	3

The table describes the situation in a company before and after the innovation of information systems.

Tab.4. Average values based on methodology of innovation IS

	Functio-nality of IS	**SW decision support**	**Data**	**Contro-lling of IT**	**Proce-sses in IT**	**Peoples in IT**	**Information technology**	**Communi-cation technology**
Before impl.	0,5	0,6	2,2	1,2	0,3	0,9	1,2	1,3
After impl.	1,7	2,2	3,2	2,2	2,5	2,0	2,6	2,1

There was calculated the average in particular areas upon of gained values. These average values represent better the current status of companies before and after the innovation. The average values are summarized in the table no. 5.

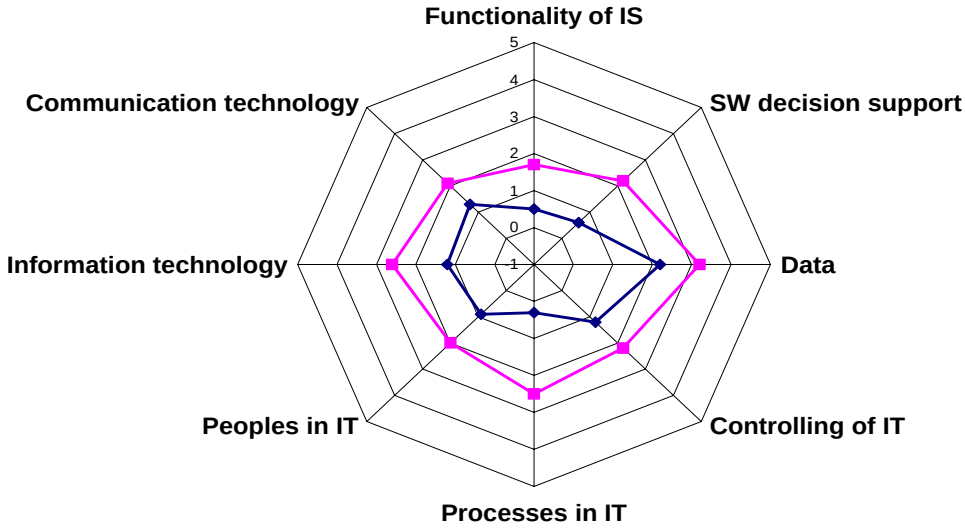

Fig.5. Graphical representation of the designed methodology of IS innovation

4.1.1. Evaluation of analysed results – before IS innovation

The table no.3 shows the status of IS before innovation. This value is under value of 1 in most cases. It means the keeping the current status of functionality. The facts gained from interviews match to the situation in analysed companies where the systems before the innovation were maintained and improved only because of unavoidable needs. It was never the systematic development of the information systems.

The functionality of the system was maintained only on the necessary level. The software support was used only in a form of special reports for accounting or production mainly. This also was one of the main reasons for the innovation of information system. The data was stored in separate databases and the shared database was applied only in minority cases. The data was not control in a central way and evidence in excel sheet was used very often by individual employees.

IT management was also done in an ad hoc as a reaction on the needs of users. There was no plan of IT development in majority of companies.

The IT processes were also described on the very low level. The main processes have been described mainly.

The training of people working with the information systems was done accidentally due to legislative changes or due to actual needs of companies. It was in no case systematically improvement of employee knowledge.

The information technology was maintained by own sources of companies respectively there was an agreement for such service.

The fragmentation of the elements in the field of communication technology was very high and the connection of several computers was effective and the building of a large network was not necessary.

4.1.2 Evaluation of analysed results – before IS innovation

The table no. 3 shows that the status of the information systems after the innovation has improved in all areas not necessary. The table shows the analysed differences. The average values after the innovation were above the value 2. It means continues proactive improvement of the systems compared with the ad-hoc approach before the innovation. The main changes were realised in the field of IT processes that was detailed described. The second most important change is the user decision support. The reason is the integrated platform of the new system and the offer of up to date and aggregate data for a whole company. The third significant place belongs to information technology that was changed due to innovation project.

Tab.5. The difference of values after the IS innovation

	Functio-nality of IS	SW decision support	Data	Contro-lling of IT	Proce-sses in IT	Peoples in IT	Information technology	Communica-tion technology
rozdíl	1,2	1,6	1,0	1,0	2,2	1,1	1,4	0,8

After innovation is the functionality of IS still being extended and also continuity to the future is ensured by using the selection of this system.

The software support of deciding is on level according to special questions and reports, which is caused to the integration of system details and the possibility of giving actual data from one point of the system in defined time. In some company they have started using business intelligence yet, it means automatically making report for selected worker or managers.

Data are after innovation almost saved in shared databases o data warehouses. This way of data saving makes possible better SW decision support, as it was mentioned. Unfortunately, there is still being tally some date in Excel sheet, it relates to minority thing.

Controlling of in IT is running according to users´ requirements, strategy keystone of development of information technology in some cases. In one case after innovation IS was happened to system degeneration with reason that mother changed IS.

Processes in IT have recognised the biggest chance in checking areas. By the innovation are mostly described almost all of them.

People, who working with IS, are educated systematically after system innovation, it is going to rise in people qualification.

There is happened a marked change in this area the information of technology and also the impact of innovation IS processing the strategy the development of HW requirements in a majority company.

In communication technology is found intranet sites and often publication of information from system on the internet and extranet for external partners. After innovation of IS majority of PC are plugged-in to intranet site.

4.1.3. Evaluation of practical verification proposed method

The result of this analyse was to accept or to refute a claim, if the proposed method of innovation ERP and their areas are useable in practice. This claim was accepted on basis the questionnaire solution and the analysis achieved results. It was shown that the methodology is able to give information about actual state of IS on basis audit this system and to suggest some areas for innovation. Innovation of IS do not have to be realised through all of areas, but just for some of them. The next caption deals with selection of areas.

Based on mentioned results is obvious, that proposed methodology is still not used completely, it means that there is a substantial potential for rising in some of areas in companies.

After innovation has almost of checked companies signed with supplier a contract of maintenance, which price is moving between 12-20% per year from licence prices of implemented system. We can see in results, that average values in checked areas are not value -1 or value 0. It means that system degeneration or system regeneration is not happened impact to maintenance, but minimally it goes to develop a current functionality IS, because automatic system innovation is part in maintenance contracts on basis legislative, legal changes and next changes. Supplier of that system gets this update or company, which has system implemented.

4.2. Theoretical verification of methodology

Based on investigation was in previous captures accepted that the method is able to give information about actual state of IS on basis audit this system and to suggest some areas for innovation. Innovation of IS do not have to be realised through all of areas, but just for some of them. This capture proves that innovation in partial area IS will have impact to next areas IS an also impact to whole IS.

Finish will be accepted on basis the correlation quantity a made mathematical models in dependence with investigative quantity.

4.2.1. Definition of statistical models

Statistic models were created for purpose to prove, that each of investigated quantities is linear depended, and by this fact confirm an assumption, that innovation in one area can have influence to whole information system. These models define the rate of this influence.

The table of selective correlation No0 define the rate of statistical linear dependence of quantities. Based on selective variance of values is defined product-moment correlation coefficient *r*. This coefficient represents the rate of linear connection between values X_i a Y_i. If the *r* is near to ± 1, is possible to exactly define the connection between values by linear relation, and based on this relation to estimate the future values. Values in table No0 are symmetric by main diagonal, and from this reason are showed only values in upper part from diagonal.

For next exploration of connection among quantities, and for confirmation hypothesis about dependence of quantities, which can cause, based on innovation in one area of information system, innovation in other areas, the attention will be focused on results acquired from data

after innovation of information system in companies. These values clearly prove the influence of innovation to final function of information system.

Table No.6 show correlation of quantities after innovation of IS.

Tab.6. Correlation of quantities – situation after innovation of IS

	Functionality of IS	SW decision support	Data	Controlling of IT	Processes in IT	Peoples in IT	Information technology	Communication technology
	A	B	C	D	E	F	G	H
A	x	0,356	0,523	0,849	0,866	0,799	0,880	0,247
B		x	0,637	0,156	0,292	0,182	0,601	0,371
C			x	0,456	0,438	0,295	0,601	0,557
D				x	0,908	0,842	0,848	0,191
E					x	0,744	0,920	0,056
F						x	0,732	0,315
G							x	0,228
H								x

The important dependence among quantities can be found in several areas. Is clearly seen the influence of Controlling of IT, Processes in IT, Peoples in IT and Information technology to Functionality of IS. This dependence does not exist in systems before innovation to SAP R/3. The next important area is influence of Processes in IT, Peoples in IT and Information technology to Controlling of IT. Processes in IT and knowledge of peoples in IT helps to better controlling of Processes in IT.

Relatively surprising finding is independence of Data in system to others part of information system. This dependency influent and supported Decision making before innovation. By the same mode the SW decision support does not have any important influence to others quantities. As statistical unimportant is connection between communication technologies and other parts of system.

For next investigation of dependence of quantities were defined statistical models based on correlation of quantities. These models were investigated by appraisal appropriates of model.

For creating of statistical models were used only values and dependences of quantities after innovation of information system, see table No0. The values were choose, where the coefficient of correlation is over + 0,7. From these quantities were created statistical models and measured their appropriateness based on statistical methods.

Statistical models were created in form $y_i = \beta_0 x_{i0} + \beta_1 x_{i1} + ... + \beta_k x_{ik} + \varepsilon_i$, where y is explicative variables and x is explanation variable.

Tab.7. Suggested statistical models

Model No.	Relation	Suggestion of model
1	Relation between Functionality IS and Controlling of IT	$A = \beta_0 + \beta_1 D$
2	Relation between Functionality IS and Processes in IT	$A = \beta_0 + \beta_1 E$
3	Relation between Functionality IS and Peoples in IT	$A = \beta_0 + \beta_1 F$
4	Relation between Functionality IS and Information technology	$A = \beta_0 + \beta_1 G$
5	Relation in Functionality IS and Controlling of IT, Processes in IT	$A = \beta_0 + \beta_1 D + \beta_2 E$
6	Relation in Functionality IS and Processes in IT, Information technology.	$A = \beta_0 + \beta_1 E + \beta_2 G$
7	Relation in Functionality IS and Controlling of IT, Processes in IT, Peoples in IT	$A = \beta_0 + \beta_1 D + \beta_2 E + \beta_3 F$
8	Relation in Functionality IS and Processes in IT, Peoples in IT, Information technology	$A = \beta_0 + \beta_1 E + \beta_F F + \beta_3 G$
9	Relation in Functionality IS and Controlling of IT, Processes in IT, Peoples in IT, Information technology	$A = \beta_0 + \beta_1 D + \beta_2 E + \beta_3 F + \beta_4 G$
10	Relation between Controlling of IT and Processes in IT	$D = \beta_0 + \beta_1 E$
11	Relation between Controlling of IT and Peoples in IT	$D = \beta_0 + \beta_1 F$
12	Relation between Controlling of IT and Information technology	$D = \beta_0 + \beta_1 G$
13	Relation in Controlling of IT and Processes in IT, Peoples in IT	$D = \beta_0 + \beta_1 E + \beta_2 F$
14	Relation in Controlling of IT and Peoples in IT, Information technology	$D = \beta_0 + \beta_1 F + \beta_2 G$

15	Relation in Controlling of IT and Processes in IT, Peoples in IT, Information technology	$D = \beta_0 + \beta_1 E + \beta_2 F + \beta_3 G$
16	Relation between Processes in IT and Peoples in IT	$E = \beta_0 + \beta_1 F$
17	Relation between Processes in IT and Information technology	$E = \beta_0 + \beta_1 G$
18	Relation in Processes in IT and Functionality of IS, Controlling of IT	$E = \beta_0 + \beta_1 A + \beta_2 D$
19	Relation in Processes in IT and Peoples in IT, Information technology	$E = \beta_0 + \beta_1 F + \beta_2 G$
20	Relation between Peoples in IT and Information technology	$F = \beta_0 + \beta_1 G$
21	Relation in Peoples in IT and Functionality of IS, Controlling of IT	$F = \beta_0 + \beta_1 A + \beta_2 D$
22	Relation in Peoples in IT and Controlling of IT, Processes in IT	$F = \beta_0 + \beta_1 D + \beta_2 E$
23	Relation in Peoples in IT and Functionality of IS, Controlling of IT, Processes in IT	$F = \beta_0 + \beta_1 A + \beta_2 D + \beta_3 E$
24	Relation in Information technology and Functionality of IS, Controlling of IT	$G = \beta_0 + \beta_1 A + \beta_2 D$
25	Relation in Information technology and Controlling of IT, Processes in IT	$G = \beta_0 + \beta_1 D + \beta_2 E$
26	Relation in Information technology and Controlling of IT, Processes in IT, Peoples in IT	$G = \beta_0 + \beta_1 D + \beta_2 E + \beta_3 F$
27	Relation in Information technology and Functionality of IS, Controlling of IT, Processes in IT, Peoples in IT	$G = \beta_0 + \beta_1 A + \beta_2 D + \beta_3 E + \beta_4 F$

Suggested statistical models for prediction of innovation

4.2.2. Appraisal appropriates of models

Appraisal of model is measured by following criteria [1]:

1. **Coefficient of determination R^2**, a statistic that is widely used to determine how well a regression fits is the coefficient of determination (or multiple correlation coefficients), R^2.
2. **Relevancy of regression test** – based on Fischer distribution. Statistic

$$F = \frac{R^2}{1-R^2}\frac{n-p}{p-1}$$

has distribution of mathematical expectation *F(p-1, n-p)*. Hypothesis H_0 is reject on level of relevancy α, if $F > F_{1-\alpha}(p-1,n-p)$.

3. **Level of relevancy test** α
4. **Eligibility of model**

Each from suggested model is tested to case, if coefficient $\beta_0 = 0$. Because values in table No0 are symmetric on main diagonal, together with model of type $Y = \beta_0 + \beta_1 X$ is assess model $X = \beta_0 + \beta_1 Y$ and with model of type $Y = \beta_1 X$ is assess model $X = \beta_1 Y$. The results of this assess will be always mentioned by assessing of models, and then will be introduce the final results of this models. In case, that models will by set as proper, the β_i coefficient will be different, bud statistical quality of model are the same.

4.2.3. Evaluation of theoretical verification of methodology

Based on statistical research and adjusted criteria are following models suitable for linear estimation of dependence of investigated quantities. Based on these models is possible to calculate value of explanation variable by explicative variables. In case, that for one suggestion there are two possible models, as suitable model was chosen that models, which has bigger value of coefficient of determination.

1. Functionality of IS (A)

Tab.8. Models for prediction of innovation in Functionality of IS area

Suggestion	Model	Final model
model No. 1	$A = \beta_1 D$	$A = 0{,}7D$
model No. 2	$A = \beta_1 E$	$A = 0{,}69E$
model No. 3	$A = \beta_1 F$	$A = 0{,}67F$
model No. 4	$A = \beta_1 G$	$A = 0{,}63G$
model No. 5	$A = \beta_1 D + \beta_2 E$	$A = 0{,}36D + 0{,}34E$
model No. 6	$A = \beta_0 + \beta_1 E + \beta_2 G$	$A = 0{,}25E + 0{,}41G$
model No. 7	$A = \beta_0 + \beta_1 D + \beta_2 E + \beta_3 F$	$A = 0{,}14D + 0{,}38E + 0{,}19F$
model No. 8	$A = \beta_0 + \beta_1 E + \beta_2 F + \beta_3 G$	$A = 0{,}24E + 0{,}18F + 0{,}27G$
model No. 9	$A = \beta_0 + \beta_1 D + \beta_2 E + \beta_3 F + \beta_4 G$	$A = 0{,}06D + 0{,}21E + 0{,}16F + 0{,}26G$

2. SW decision support (B)

Models suggested for this area does not fulfil the criteria defined for appraisal appropriates of models.

3. Data (C)

Models suggested for this area does not fulfil the criteria defined for appraisal appropriates of models.

4. Controlling of IT (D)

Tab.9. Models for prediction of innovation in Controlling of IT area

Suggestion	Model	Final model
model No. 1	$D = \beta_1 A$	$D = 1{,}35A$
model No. 10	$D = \beta_0 + \beta_1 E$	$D = 0{,}95E$
model No. 11	$D = \beta_1 F$	$D = 0{,}94F$
model No. 12	$D = \beta_1 G$	$D = 0{,}87G$
model No. 13	$D = \beta_0 + \beta_1 E + \beta_2 F$	$D = 0{,}60E + 0{,}39F$
model No. 14	$D = \beta_0 + \beta_1 F + \beta_2 G$	$D = 0{,}34F + 0{,}58G$
model No. 15	$D = \beta_0 + \beta_1 E + \beta_2 F + \beta_3 G$	$D = 0{,}39E + 0{,}33F + 0{,}24G$

5. Processes in IT (E)

Tab.10. Models for prediction of innovation in Processes in IT area

Suggestion	Model	Final model
model No. 2	$E = \beta_1 A$	$E = 1{,}38A$
model No. 10	$E = \beta_1 D$	$E = 0{,}99D$
model No. 16	$E = \beta_1 F$	$E = 0{,}91F$
model No. 17	$E = \beta_0 + \beta_1 G$	$E = 0{,}89G$
model No. 18	$E = \beta_0 + \beta_1 A + \beta_2 D$	$E = 0{,}80A + 0{,}43D$
model No. 19	$E = \beta_0 + \beta_1 F + \beta_2 G$	$E = 0{,}02F + 0{,}87G$

6. Peoples in IT (F)

Tab.11. Models for prediction of innovation in Peoples in IT area

Suggestion	Model	Final model
model No. 3	$F = \beta_1 A$	$F = 1{,}33A$
model No. 11	$F = \beta_1 D$	$F = 0{,}96D$
model No. 16	$F = \beta_1 E$	$F = 0{,}90E$
model No. 20	$F = \beta_1 G$	$F = 0{,}84G$
model No. 21	$F = \beta_1 A + \beta_2 D$	$F = 0{,}52A + 0{,}60D$
model No. 22	$F = \beta_1 D + \beta_2 E$	$F = 1{,}17D - 0{,}21E$
model No. 23	$F = \beta_1 A + \beta_2 D + \beta_3 E$	$F = 0{,}94A + 0{,}82D - 0{,}53E$

7. Information technology (G)

Tab.12. Models for prediction of innovation in Information technology area

Suggestion	Model	Final model
model No. 4	$G = \beta_1 A$	$G = 1{,}53A$
model No. 12	$G = \beta_1 D$	$G = 1{,}09D$
model No. 17	$G = \beta_1 E$	$G = 1{,}08E$
model No. 20	$G = \beta_1 F$	$G = 1{,}03F$
model No. 24	$G = \beta_0 + \beta_1 A + \beta_2 D$	$G = 0{,}98A + 0{,}40D$
model No. 25	$G = \beta_0 + \beta_1 D + \beta_2 E$	$G = 0{,}48D + 0{,}62E$
model No. 26	$G = \beta_0 + \beta_1 D + \beta_2 E + \beta_3 F$	$G = 0{,}34D + 0{,}65E + 0{,}12F$
model No. 27	$G = \beta_0 + \beta_1 A + \beta_2 D + \beta_3 E + \beta_4 F$	$G = 0{,}68A + 0{,}24D + 0{,}39E - 0{,}01F$

8. Communication technology (H)

Models suggested for this area does not fulfil the criteria defined for appraisal appropriates of models.

From final models is seen, that investigated quantities are linearly dependent. It means that innovation in one area of information system will have influence to whole system. This influences are described in tables No0 up to No0. There were no suitable models that fulfil the criteria defined for appraisal appropriates of models, for SW decision support, Data and Communication technology. It means that innovation in these areas will not have important influence to other investigated areas. This reality will be important in decision making process of innovation of information system, and adjudication of investments to areas of information system.

From created models is possible to estimate the influence of innovation in one area to others areas of information system. As an example can be showed innovation in Controlling of IT. If the company decide to develop and invest to this area, this investment will have impact in others areas. The level of this dependence in showed by following models: Functionality of IS - $A = 0{,}7D$, Processes in IT - $E = 0{,}99D$, and Peoples in IT - $F = 0{,}96D$, Information technology - $G = 1{,}09D$. It means, that if company decide to raise Controlling of IT about 1 level, this innovation cause improvement in others areas by way defined by statistical models. This knowledge can help to managers of company in decision making about investments to information system.

From created models is possible to estimate the influence of innovation in more areas to others areas of information system too. As an example can be showed innovation in areas Peoples in IT and Processes in IT. If this combination of innovation will be made in company, by the statistical models is again possible to estimate the impact to following area of information system: $D = \beta_0 + \beta_1 E + \beta_2 F$.

The knowledge of this statistical models and dependences can by powerful aim to management of company in process of deciding about innovation of information system. This dependences helps to management find out the suitable areas for innovation of information system from investments and profit point of view.

As a support for deciding was created application in MS Excel, which is able to estimate the assets on investments to selected areas of information system, based on set up information about current an intended state in company. The management is able to simulate the asset of investments and find out the suitable combination of level and areas of information system. The scheme of application is on the picture No0.

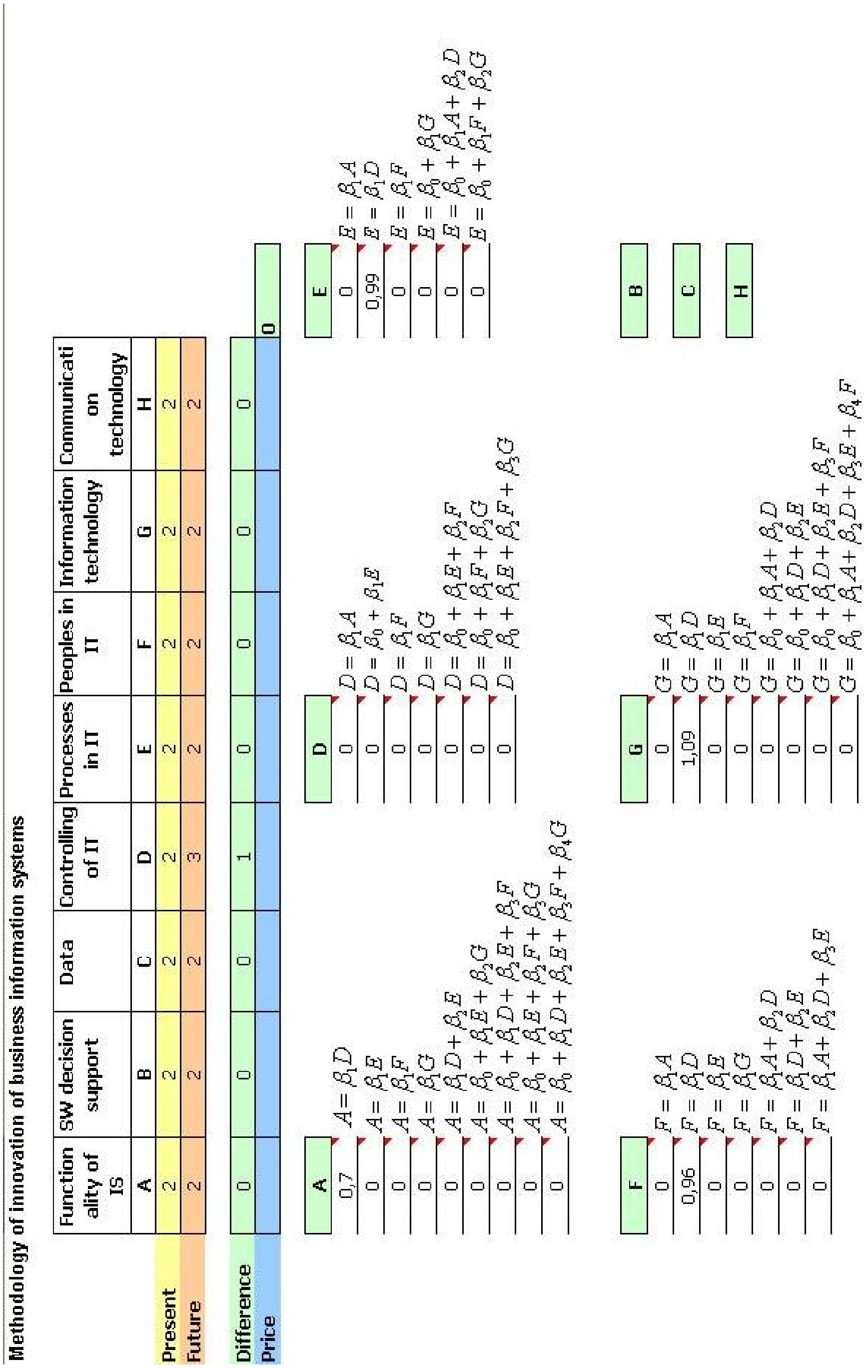

Fig.6. Modelling of assets of innovation

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