Justyna PATALAS*, Tadeusz KRUPA **

THE ERP CLASS SYSTEM OBJECTIVE ASSESSMENT METHOD

Abstract

This paper presents ERP class system objective assessment method when using the neural systems GMDH basing on the Ivachnienko algorithm. An approach to ERPs evaluation aimed at their successful implementation into a class of the small and medium-sized enterprises (SMEs) is considered. The set of performance indices supporting an ERP evaluation in the context of its implementation into a given SME is proposed. Consequently the decision model binding the selected indicators of effectiveness of SME implementation with the parameters of a given ERP system and the parameters of the company as such, which introduced this system is discussed.

1 INTRODUCTION

The success of the implementation of EPR class is conditioned by many factors [1] [2], which defining of a company functional areas can be pointed out along with the definition of the user's needs. The ability to meet the information needs is based on the fact that both the internal and external users are provided with essential information which are properly introduced and updated.

The access to vital information which is crucial in achieving economical objectives, for a company in a given time, affects the process of decision making as far as the application of the integrated resource management system is concerned. The development of information systems results in finding of new solutions in the area of ERP systems. The developers of such systems becoming more and more sensitive to the market demands, thus modifying the ERP system functionality areas as to meet a SME‘s needs. Apart from the basic ERP modules, operating on the base of the integrated and accessible database which includes: purchase, production, material management, sale, costs calculation, fix assets, financial and accounting module, there are a new modules coming to existence such as; Supply Chain Management, e-commerce techniques like ERP-B2B, B2C, Business Intelligence portals, mobile solutions, CRM (Client Relation Management) and Work flow Management. Each of the modules serves particular functions in the sphere of company area support.

* M. Sc., University of Zielona Góra, The Center of Enterprises and Technology Transfer, Wojska Polskiego St. 69, 65-762 Zielona Góra

** Prof., Warsaw University of Technology, Faculty of Production Engineering, Narbutta St. 85, 02-524 Warszawa

SMEs that are about to make decision concerning the introduction of ERP system tend to make a pre-evaluation of the efficiency of the very implementation (for example taking into consideration the level of the user's objectives realization). However the process of the efficiency evaluation is very expensive, time consuming and followed by complicated analyzes, which means that companies tend to opt for any products that are not really adjusted to their needs. Bearing this in mind, there is a demand for developing the method that would diminish the risk of an inadequate implementation and at the same time would allow to solve the problems which otherwise could be missed. It can be concluded that there is a need to define the criteria of the ERP system efficiency in the SME that should be carried out on the basis of the functionality area definition. Consequently an appropriate reference model of the company should be developed to enable both defining the needs in the areas of functionality and the success evaluation of ERP implementation. Such a model should provide a kind of guideline for the future ERP implementation framework.

In other words, we are looking for an answer whether a given ERP guarantee to obtain the assumed level of a SME performance index for assumed costs and existing limitations or not? The problem belongs to a class of the small and medium-sized enterprises (SMEs) and ERP system directory, where the problem of finding a feasible solution is using of ERP class system objective assessment method.

2. SME MODELING

In order to show the possibility of defining such a model let us consider the SME that deals with providing services for both organizations and individual customers (projects). The main areas of the company correspond to the following functions supporting: the sale, the supply, the orders scheduling, the service, the accounting, human resources management, export/import transactions (Fig.1).

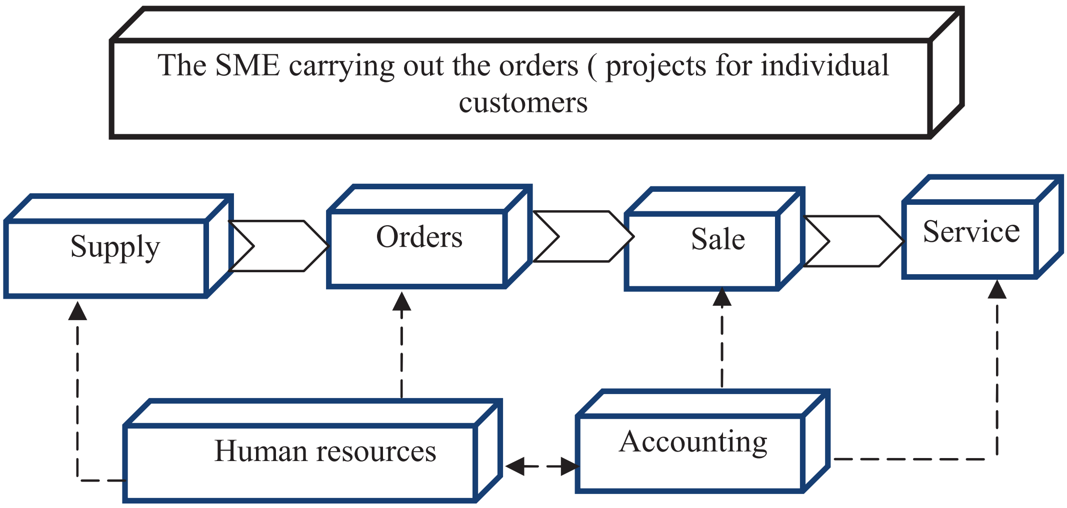

Fig.1. Company of SME

For all the employees to have an access to the essential information from particular sections the management of the company decided to introduce ERP system. In the initial stage of making the decision and the system evaluation it is necessary to specify the demands of the user in relation to the system because not every area of system functionality is crucial for each user. Thus the efficiency of ERP system implementation depends on the needs and priorities of a particular user. The main objective of a further analysis is to define the structure of the business processes in the area of functionalities such as a sale (Fig. 2).

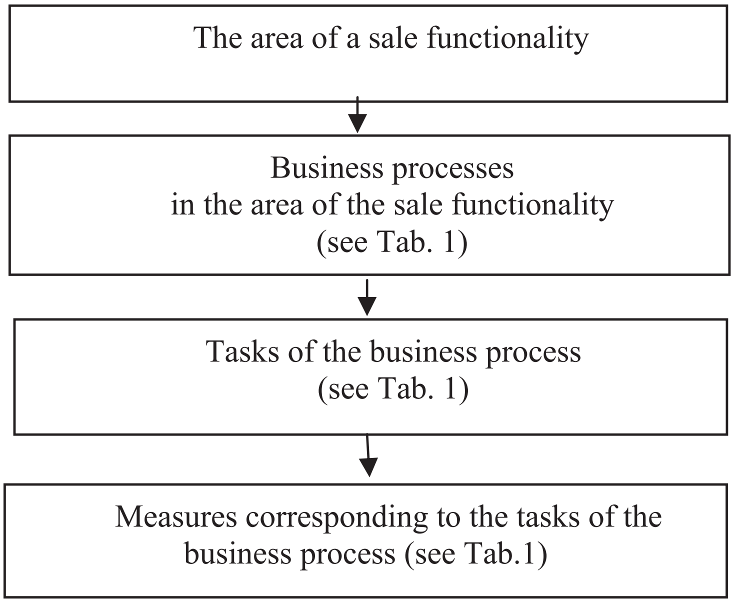

Fig.2. The structure of the business processes in the area of a sale functionality

The structure of business processes for the particular area of functionality is shown in Tab. 1. This structure results from a specific character of the company business activities, which differ from company to company. In addition the business processes structure tends to change with the ongoing development of the company. In order to define the indices of the successful implementation of ERP system a detailed specification of the proceeded activities within the area of functionality should be carried out, taking into account a sale preparation process (Tab.1).

The introduction of ERP system should improve the level of the defined indicators in the company within a specific area of functionality. The ERPs' functionality analyzes shows that in a given company there is a need to implement only some of the solutions offered by the software distributors. So, it is essential to define a priority list as well as the control indicators which would determine the level of implementation success. In the case considered, it is assumed that the indicators are defined adequately to the tasks that are proceeded in the course of the business process, i.e., a sale preparation (contract registry).

3.PERFORMANCE MEASURES OF ERP IMPLEMENTATION

The characteristic of the business process is carried out through the sale preparation (contract registry) in the area of the sale functionality, and is defined by objectives and particular tasks specified (see Tab.1). The implementation of the ERP should result in meeting the objectives outlined above that is why it is important to define that had been assumed before in the business process.

Tab.1. Indices corresponding to the sale preparation (contract registry) in the area of sale functionality

		Tasks in the business process *Sale preparation* (contract registry)	Objectives	Measures
The areas of functionality-sale	business process, sale preparation (contract registry) in the areas of functionality-sale	Price list-set up and update	Customers response	R_k - profitability of own capital R_o - profitability of turn-over
		Guidelines for order handling	Resources flow	$P_ś$ turn over money flow R_a - assets profitability, R_{k1} - profitability of costs
		Contracts record	Reaching 80% level of deadline requirements	R_z - profitability of employment
		Price negotiation	Increase in sale income	S_w - Average value of orders (in %) R_a - assets profitability, R_{k1} - profitability of costs
		Payment methods	Payment flow	$P_ś$ - turn over money flow
		Overall record proceedings and terms for contracts agreement, contract deadline, requirements analysis	Reaching 80%+ level in meeting 80%	C_r – time of during of orders
		Set up, record and update of "payment trouble" contractors	Financial flow	$P_ś$ - turn over money flow
		Orders handling methods	New customers targeting	U_{zzt} – planning orders (in %)
		Contract negotiation methods	Sustaining permanent customers policy	R_n - turn over money amount
		Non-paying contractors proceedings	Reaching 80%+ level in payment deadline requirements	U_r – complain supply (in %)

4. PROBLEM FORMULATION

In the paper we propose the SME modeling is carried out through the sale preparation (contract registry) in the area of the sale functionality, and is defined by objectives and particular tasks specified. A problem can be stated as follows. Consider a set of ERP systems ascribed to SME as well as to a company module of SME. The question is whether a given ERP will guarantee to obtain the assumed level of a SME performance index or not? A relevant framework to this issue is based on a database referring to:

- ERP system directory, ascribed to SME as well as to a company module of SME sector, with a defined functionality areas. Allowing responding to the following question: Which indices encompass the success of ERP system implementation and what system ensures the back up in the key areas of the company operation?
- The SME model, with defined functionality areas, and the information system to be implemented. Allowing responding to the following question: How to evaluate the effects of the system implementation?

In that context exist the need of making the SME directory and ERP system directory, ascribed to SME. However the question: whether a model of the assessment of the effective implementation of the ERP system in the company?

5. THE ERP CLASS SYSTEM OBJECTIVE ASSESSMENT METHOD

In order to proceed the ERP cost analysis it is best to use the Total Cost of Ownership method which was developed by Gartner Group. When we use this method it is essential to take into consideration, not only the equipment software and implementation costs, but also the delay management development communication, support as well as the end user costs. Having done the advantage analysis and the costs evaluation it is necessary to analyze the investment return. Unfortunately, due to a dynamic character of ERP type of investments the most popular ROI method does not include the complexity of a company investment in ERP system.

There are, however, a few methods designed to evaluate the profitability of the information technology investments such as; Earned Value Added, Return on Management, Return on Opportunity,(modified) Total Benefits of Ownership (TCO) and Total Benefits of Ownership method .These methods include the effects which are, normally, hard to measure because the implementation of ERP involves the effects measured in money terms including the time and risk factor. Another element that should be taken into consideration is ERP system development plan which follows the implementation. Bearing in mind a dynamic development of ERS systems, it can be assumed that the application of this system will never come to halt, nevertheless it will not take so much work. ERP planning along with a development of the company should include the new products development support with; multi company co-operation, implementation of new logistic technology such as; data store, automatic identification, flexible production lines, monitoring and so on.

The point is, however, that even cost evaluation process turns out be complicated. It is conditioned by the fact that the costs of software purchase, hardware, net installation with implementation and training can be determined but the problems arise when it comes to the evaluation of the real costs, in terms of work load necessary to maintain proper functioning of the organizational change, which may be different from what had been assumed before. It is also difficult to assess the costs that the company would have to bear due to the employee new system training. The ERP class evaluation method enables us to assess objectively the effective implementation of the system in the company.

5.1 Iwachnienko algorithm in the profitability assessment of the it implementation in ERP project within SME class company

The company structural identification analysis model with the least square method enables us to evaluate economical effects of ERP implementation. So, the possibility of finding or selecting a model, that would indicate the relation between the indicators change and ERP implementation, is considered. The process of forecast involves defining what data should be forecast as well as determining the factors that would affect the data. In the course of profitability forecast for IT project realization a choice of the company profit comes as a parameter to be examined.

In order to obtain a forecast it is necessary to have an access to the data from the past. The date which was used in this assessment come from 1999 – 2003. The data was collected from the companies operating within SME sector where ERP system was applied and these companies belonged to ERP defined class group (see ERP class system). The data was obtained as a result of the research which was carried out on the area of Lubuskie region, Poland. It made the identification of decision making model possible which bounds the selected indicators of ERP implementation effectiveness with ERP parameters (characteristics) along with the company parameters. The following data (indicators value) was collected; profitability of own capital – R_k (after tax profit/own capital), profitability of turn-over - R_o (profit+foreign capital interest rates/total capital), turn over money flow – $P_ś$ (money flow/short term payments), assets profitability R_a (profit after tax / overall assets), profitability of costs – R_{k1} (total costs/turn over) , profitability of employment – R_z (profit after tax/ average employment)

The sample of the data for the companies belonging to a defined class of companies (see SME company class) ,which makes a part of the initial data for the Iwachnienko algorithm, are shown in Table 2. The main area of study covers; sale, supply orders, service, accounting, human resources, and export sale.

Tab.2. Sample data for the company group A

Year	R_k	R_o	$P_ś$	R_a	R_{k1}	R_z	Y (profitability in tyś PLN)
1999	0,79	0,8	0,03	0,4	0,9	0,86	1564
2000	0,84	0,85	0,03	0,38	0,95	0,63	1484
2001	0,85	0,86	0,04	0,4	0,98	0,63	1627
2002	0,86	0,88	0,04	0,4	0,96	0,62	1781
2003	0,87	0,77	0,05	0,44	0,95	0,66	2060

The data in table 2 is divided into testing and interactive data.

Tab.3. Interactive data

Year	R_k	R_o	$P_ś$	R_a	R_{k1}	R_z	Y (profitability in tyś PLN)
1999	0,79	0,8	0,03	0,4	0,9	0,86	1564
2001	0,85	0,86	0,04	0,4	0,98	0,63	1627
2003	0,87	0,77	0,05	0,44	0,95	0,66	2060

Tab.4. Testing data

Year	R_k	R_o	$P_ś$	R_a	R_{k1}	R_z	Y (profitability in tyś PLN)
2000	0,84	0,85	0,03	0,38	0,95	0,63	1484
2002	0,86	0,88	0,04	0,4	0,96	0,62	1781

Setting up the structure for the object (company decision making model) with the parameter identification model of developed structure involves a great deal of calculation , especially in the case of the object high initial input number The complication that the calculation of the algorithm involves was greatly reduced by implementing GMDH method. This method was developed by A.G. Iwachnienko and it is known as *Iwachnienko algorithm* or Group Method of Data Handling This method came into existence as a result of combination of MNK Gauss optimalization theory and Goedl logical openness theory, which makes a completion of the Iwachnienko hierarchical synthesis procedure. The discussion which is carried out here concerns Iwachienko algorithms which enables to define its particular steps.

Step 1. Identification

Multilevel algorithm GMDH enables us to perform optimalisation synthesis of the mathematical model for a given class of the regression function and it can be used in evaluation criteria choice as well as the estimation quality assessment. Both elements of the algorithm are defined arbitrarily by the developer that is why modeling must be proceeded by an initial identification phase which allows for both defining the choice and the class of the solutions in progress. Taking into account a specific kind of the objects in question, along with specific solution tasks(evaluation of the system implementation profitability for ERP defined class company), it can be assumed that the regression function takes a form of two variables A particle selection of integers is carried out with the regularity criteria.

Step 2. Defining population of particle model

Developing an object model with GMDH algorithm is carried out in steps. At every step the population regression integer is being generated. Because it was established that each of them is a function of two variables, the polynomials are assigned to every possible pairs of arguments. Their parameters are calculated using the method of the *least squares* ,that is, using the sets of equation formulas. It can be concluded that GMDH procedure is conditioned by a linear unit independence, which is a guarantee for the solution to be found.

Step 3. Particle model selection

Having generated the families of regressive polynomial, a selection takes place of those which approximately fit in an interdependence under examination. Due to calculation assumptions, the restriction is assumed that the number of data (models) in a new population can not be higher than in the previous one.

Step 4

For each population of particle solutions the lowest regularity criteria value is assigned (3). The steps 2 and 3 go through a loop until the value stops decreasing. It means that the optimal model was found which is an polynomial of regression for which the criteria has reached the lowest value. Its arguments are polynomials from the previous interaction (u),(v).

So, for the object from Tab. 2 of the output x_1, x_2,..., x_6 and of one output y the matrix X is made:

$$X = \begin{bmatrix} 0{,}79;0{,}8;0.03;0{,}4;0{,}9;0{,}86 \\ 0{,}85;0{,}86;0{,}04;0{,}4;0{,}98;0{,}63 \\ 0{,}87;0{,}77;0{,}05;0{,}44;0{,}95;0{,}66 \\ \hline 0{,}84;0{,}85;0{,}03;0{,}38;0{,}95;0{,}63 \\ 0{,}86;0{,}88;0{,}04;0{,}4;0{,}4;0{,}96;0{,}62 \end{bmatrix} \quad \text{learning data / testing data}$$

columns 1,..., 6 represent independent variables x_1, x_2, ..., x_6 and vector y of the output value $y = [y_1, y_2, ..., y_6]^T$ = [1564,1484,1627,1781,2060]. It is assumed that the columns of the matrix X are line independent The line represents the sub division into learning data (t = 1,2,3) and testing data (n = 4,5). The learning date will be used for an object model constructing and testing data for a particle model evaluating.

In the first step, for each pair of independent variables x_p x_q p = 1, 2,..., 5, q = p+1,..., 6 the polynomial is created approximating the overall form.

$$y^* = A_{pq} + B_{pq} x_p + C_{pq} x_q + D_{pq} x_p^2 + E_{pq} x_q^2 + F_{pq} x_p x_q \qquad (*)$$

which is called Iwachienko polynomial

Polynomial factors (*) are assigned for t=3 learning observation using the method of *least squares* that is conditionals

$$S_R = \sum_{i=1}^{t} (y_i - y_i^*)^2 = \min \qquad (1)$$

where

$$y_i^* = A_{pq} + B_{pq} x_{ip} + C_{pq} x_{iq} + D_{pq} x_{ip}^2 + E_{pq} x_{iq}^2 + F_{pq} x_{ip} x_{iq} \qquad (2)$$

so for each pair of independent variables there is – for x1 x2

- for x_1, x_2 there is:

$$y_1^* = A_{12} + B_{12}x_{11} + C_{12}x_{12} + D_{12}x_{11} + E_{12}x_{12}^2 + F_{12}x_{11}x_{12}$$
$$y_2^* = A_{12} + B_{12}x_{21} + C_{12}x_{22} + D_{12}x_{21} + E_{12}x_{22}^2 + F_{12}x_{21}x_{22}$$
$$y_3^* = A_{12} + B_{12}x_{31} + C_{12}x_{32} + D_{12}x_{31} + E_{12}x_{32}^2 + F_{12}x_{31}x_{32}$$

- for x_1, x_2 x_2, x_3 there is:

$$y_1^* = A_{23} + B_{23}x_{12} + C_{23}x_{13} + D_{23}x_{12}^2 + E_{23}x_{13}^2 + F_{23}x_{12}x_{13}$$
$$y_2^* = A_{23} + B_{23}x_{22} + C_{23}x_{23} + D_{23}x_{22}^2 + E_{23}x_{23}^2 + F_{23}x_{22}x_{23}$$
$$y_3^* = A_{23} + B_{23}x_{32} + C_{23}x_{33} + D_{23}x_{32}^2 + E_{23}x_{33}^2 + F_{23}x_{32}x_{33}$$

- for x_3, x_4 there is:

$$y_1^* = A_{34} + B_{34}x_{13} + C_{34}x_{14} + D_{34}x_{13}^2 + E_{34}x_{14}^2 + F_{34}x_{13}x_{14}$$
$$y_2^* = A_{34} + B_{34}x_{23} + C_{34}x_{24} + D_{34}x_{23}^2 + E_{34}x_{24}^2 + F_{34}x_{23}x_{24}$$
$$y_3^* = A_{34} + B_{34}x_{33} + C_{34}x_{34} + D_{34}x_{33}^2 + E_{34}x_{34}^2 + F_{34}x_{33}x_{34}$$

- for x_4, x_5 there is:

$$y_1^* = A_{45} + B_{45}x_{14} + C_{45}x_{15} + D_{45}x_{14}^2 + E_{45}x_{15}^2 + F_{45}x_{14}x_{15}$$
$$y_2^* = A_{45} + B_{45}x_{24} + C_{45}x_{25} + D_{45}x_{24}^2 + E_{45}x_{25}^2 + F_{45}x_{14}x_{25}$$
$$y_3^* = A_{45} + B_{45}x_{34} + C_{45}x_{35} + D_{45}x_{34}^2 + E_{45}x_{35}^2 + F_{45}x_{34}x_{35}$$

- for x_5, x_6 there is:

$$y_1^* = A_{56} + B_{56}x_{15} + C_{56}x_{16} + D_{56}x_{16}^2 + E_{56}x_{16}^2 + F_{56}x_{15}x_{16}$$
$$y_2^* = A_{56} + B_{56}x_{25} + C_{56}x_{26} + D_{56}x_{26}^2 + E_{56}x_{26}^2 + F_{56}x_{25}x_{26}$$
$$y_3^* = A_{56} + B_{56}x_{35} + C_{56}x_{36} + D_{56}x_{36}^2 + E_{56}x_{36}^2 + F_{56}x_{35}x_{36}$$

It is possible to obtain a forecast by the approach in the output vector Y . A company profit value is placed in the following years, on the other hand, he approximate values from selected companies are placed in within X matrix. Due to this procedure the output parameters values can be determined, which is used for determining future profits for the company with a certain approximation. This approach will provide the effects if the following points will be assumed:

- A company *A* is a static object with enough approximation company class definition (only then the the advanced Iwachenko algorithm makes sense)
- The polynomial makes a good mathematical model of the object.
- The output parameters values do not change critically within a period of time.

Altogether there are 15 polynomials. Each polynomial y_i^* is being evaluated for all the observation from the X matrix The values that are calculated are placed in separate supporting columns of Z matrix.

$$Z = \begin{bmatrix} 3420;2050,3031;...;4006 \\ 1490;2050;2090;...;3035 \\ 5253\ 6100;6500;...;7200 \end{bmatrix}$$

In the second step, for each column j=1,2,...,15 of Z matrix an equality criteria is assigned from the formula:

$$r_j^2 = \frac{\sum_{i=t+1}^{n}(y_i - z_{ij})^2}{\sum_{i=t+1}^{n} y_i^2} \tag{3}$$

Where: j = 1,…, 15

The result is an estimation of the value of the proximal. So,

R_1= 2,34 R_2= 5,68; R_3= 3,25; R_4= 6,54; R_5= 7,8; R_6= 3,08; R_7= 9,25; R_8= 4,33; R_9= 5,44; R_{10}= 6,8; R_{11}= 3,25; R_{12}= 6,78; R_{13}= 3,25; R_{14}= 6,54; R_{15}= 7,8

In the third step, the selection of the best polynomials takes place – of the least r factor value. If it is assumed that there is some stability in polynomial from Z matrix a selection of m column can be made, which are assigned to X matrix. In this way the output data become the input data for the next generation process.

So, in the following steps of the process we can come up with two polynomials with the least value of r factor:

$$y_1^* = A_{12} + B_{12}x_{11} + C_{12}x_{12} + D_{12}x_{11}^2 + E_{12}x_{12}^2 + F_{12}x_{11}x_{12}$$

$$y_1^* = -6901{,}50 + 14333{,}46x_{11} - 6682{,}39x_{12} + 1864{,}15x_{11}^2 - 698{,}10x_{12}^2 + 5722{,}13x_{11}x_{12} \tag{u}$$

$$y_2^* = A_{34} + B_{34}x_{23} + C_{34}x_{24} + D34x_{23}^2 + E_{34}x_{24}^2 + F_{34}x_{23}x_{24}$$

$$y_2^* = -4800 + 12543x_{23} - 4532x_{24} + 1239x_{23}^2 - 432x_{24}^2 + 4356x_{23}x_{24} \tag{v}$$

The y_1^*, y_2^* polynomial arguments make up the initial signals for the next polynomials as a result of each step we have a set of elements from which those that make a modeling of the object in the worst way are rejected. The regularity criteria is used to determine an error of the proceeded neuron which has been already learned. On this basis of the decision id made as far as the neuron inclusion or exclusion is concerned. In order to complete each step of GMDH network synthesis it is necessary to check the optimalisation criteria:

$$Q_{min} = R_{min} \tag{4}$$

In this way the process of network evaluation is carried out until the value of the criteria increases. After the process is finished the best polynomial from the previous generation is selected. The result of the algorithm is the polynomial which is a model of the object.

So, in the three following steps the following values are obtained:

$Q_{min1} = 2,34$
$Q_{min2} = 1,88$
$Q_{min3} = 2,03$

The second layer is the optimal layer that terminated the GMDH network synthesis process (see Fig.3)

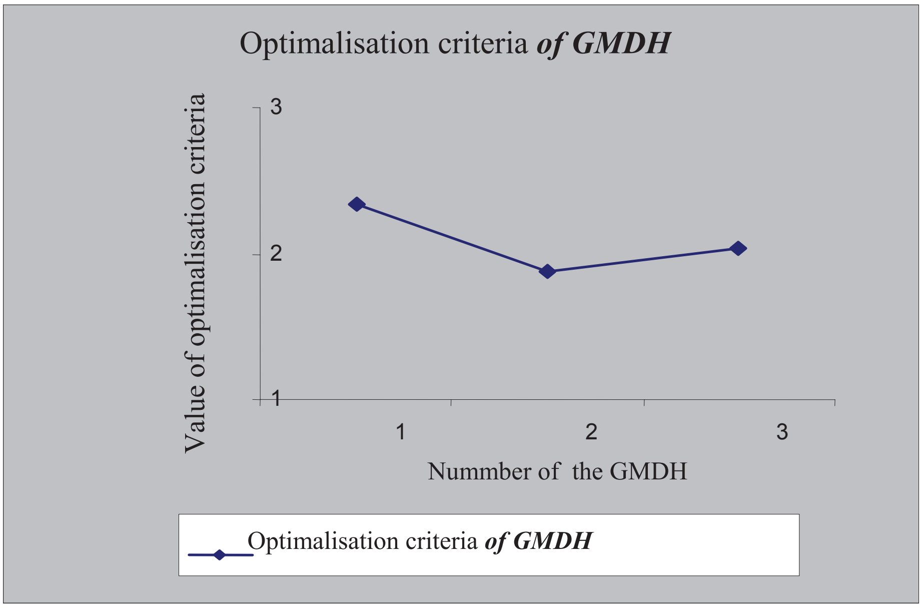

Fig.3. Graphical representation of GMDH network synthesis process

As a result (according to *learning* data) the decision making model for the company is obtained which encompasses (after rejecting the sequence of interactions that are defined by indicators of the company) the following indicators of (u) value for profitability of the company turn-over, and indicator (v) which is the indicator for profitability of the company costs.

$$y^{**} = A_1 + B_1 u + C_1 v + D_1 u^2 + E_1 v^2 + F_1 uv$$

$$y^{**} = -5480 + 12500u - 5400v + 1500u^2 - 500v^2 + 5600uv\,,$$

where:
u- stands for turn over profitability indicators
v- stands for costs profitability indicator

For the testing data set the same procedure, which is for learning is carried out. As a result of the following calculations we come up with this final model:

$$y^{***} = -4876 + 12250u - 5430v + 1300u^2 - 500v^2 + 6700uv$$

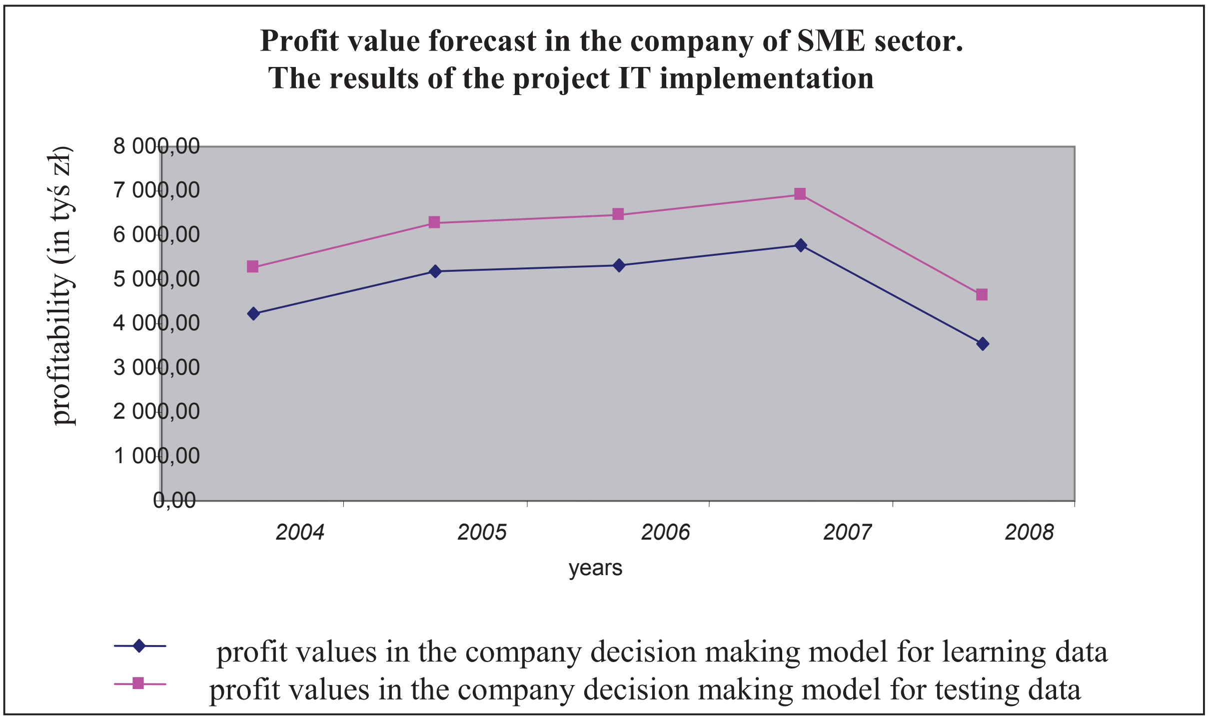

Fig.4. Profit value forecast in the company of SME sector - the results of the project IT implementation

As a result of Iwachnienko algorithm application the polynomial is obtained for a description of the company profitability.

In conclusion the decision model, which was under examination, binds the selected indicators of effectiveness of SME implementation with the parameters of a given ERP system and the parameters of the company as such, which introduced this system. This restriction makes the decision making process simple and brings it to some kind of pattern of the restriction propagation (chosen decision making indicators of implementation for the ERP system under examination that is; turn-over profitability value and profitability value).

The main problem that involves decision making process, which is understood as a problem of such an ERP system selection that would guarantee the improvement of the indices previously determined by the user, involves the ERP implementation with the research method that would define the efficiency of a given implementation. The selected measures enable us to proceed monitoring of a group of companies that are similar in relation to the user`s demands and also gives way to the development of ERP group system which would meet the required demands.

It means that, for some companies, the assessment of the effects which ERP would bring can be done on the basis of previously defined indicators and the experience of those companies which have already applied ERP integrated information system.

Structural identification of the company analytical model using the least squares method enables us to evaluate the economical effects of ERP implementation In the research to follow it is planned to develop identification model for a chosen class consisting of many sub-models that would set out the overall structure in the area of a company functionality along with the information bank containing particular database as a result of identification.

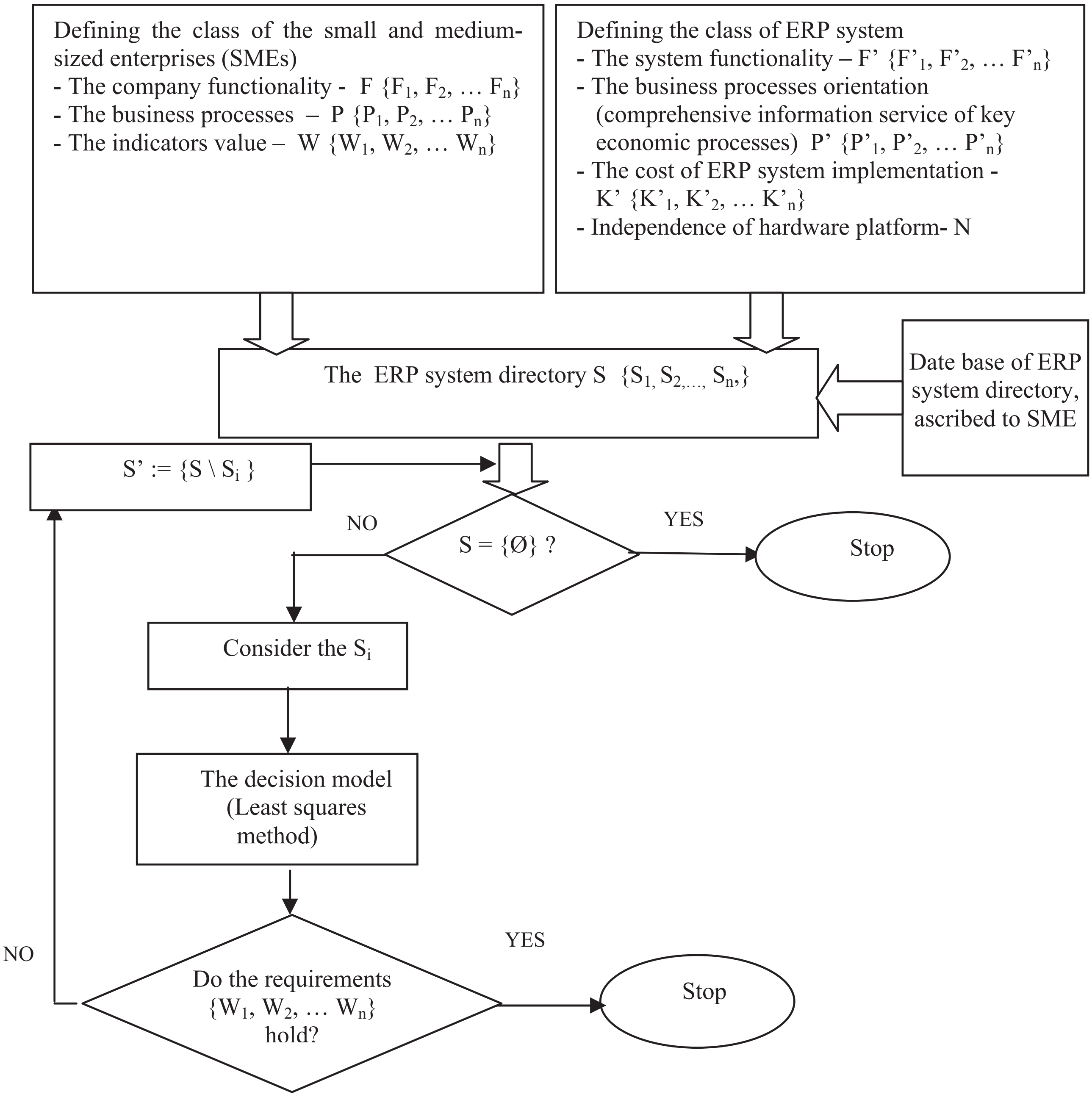

Fig.5. Procedure for ERP evaluation

In order to illustrate the procedure supporting a decision maker (Fig. 5) let us consider the SME that is about to make decision concerning the introduction of ERP system.

Consider the company A (the object), that belong to the companies class (See company class -K), that is about to make decision concerning the introduction of ERP system. The main areas of the company correspond to following functions supporting: the sale, the supply, long to the orders scheduling, the service, the accounting, human resources management, export/import transactions (Fig.1).

The ERP implementations can be concluded that the company will receipt the system described to company's needs and budget. The finally decision is connected with effects of the system implementation. The presented method enables us to make the Decision Support Systems - the decision model binding the selected indicators of effectiveness of SME implementation with the parameters of a given ERP system and the parameters of the company as such, which introduced this system. In order to illustrate this problem let us consider a particular steps of the procedure supporting a decision maker.

1. Defining the company A:
   - the company functionality – F ={F_1,= the sale, F_2 = the supply, F_3 = long to the orders scheduling, F_4 = human resources, F_5 = the accounting}
   - the business processes - P={P_1 = sale preparation (contract registry)}
   - The indicators value– W = {W_1 = profitability of turn over money flow, W_2 = profitability of costs }

2. Defining the class of ERP system ascribed to company's needs:
   - the system functionality – F'= {F'_1= the sale book, F'_2 = the task book, F'_3 = the means of payment, F'_4 = the human resources , F'_5 = the sale, F'_6 = the analyze, F'_7 = the warehouse}
   - The business processes orientation (comprehensive information service of key economic processes - P'={P'_1 = the list of turn over money flow, P'_2 = Defining the sale paper, P'_3 = The Price list-set up and update, P'_4 = using of the cost method: FIFO, LIFO, AVCO, QUAN}
   - The cost of ERP system implementation - K' ={K'_1= 30 tyś PLN }
   - Independence of hardware platform – N = {the hardware platform = Microsoft SQL Serwer, Microsoft Windows}

3. Chosen the ERP systems ascribed to company's Needs from date base of ERP system directory (See the ERP class):
   - Pro Alpha
   - Comarch Opt!ma CDN

4. Using the decision model binding the selected indicators of effectiveness of SME implementation with the parameters of a given ERP system and the parameters of the company as such, which introduced this system

The main problem in responding to the question whether a given ERP will guarantee to obtain the assumed level of a SME performance index for assumed costs and existing limitations or not – is the presented like the decision problem. In order to illustrate the possibility of answer let us consider the situation: the problem considered regards of chosen the ERP system objective and of assessment of effects of the system implementation.

The decision model:

$$y^{***} = -4876 + 12250u - 5430v + 1300u^2 - 500v^2 + 6700uv$$

where:
u- profitability value indicator (profit/total capital),
v- profitability value (total costs/turn)

which has been defined enables us to carry out an assessment of the profitability value indicator connected with realization of ERP implementation. This model is a synthetic indicator of effectiveness that consist of certain particle indicators (u- turn-over profitability value indicator (profit/total capital) , v- profitability value (total costs/turn-over) (See Tab.3):

Tab.5. Financial date (company A)

Time (Financial date)	profitability *(in tyś PLN)*	*Total capital (in tyś PLN)*	*Total cost (in tyś PLN)*	*Tur-over (in tyś PLN)*
31.12.2000	42,35	169,62	3590,26	3620,68
31.12.2001	56,91	196,11	3752,03	3822,29
31.12.2002	190,21	329,40	3980,41	4215,24
31.12.2003	235,05	374,25	3995,49	4285,68
31.12.2004	276,75	415,94	3520,86	3862,53

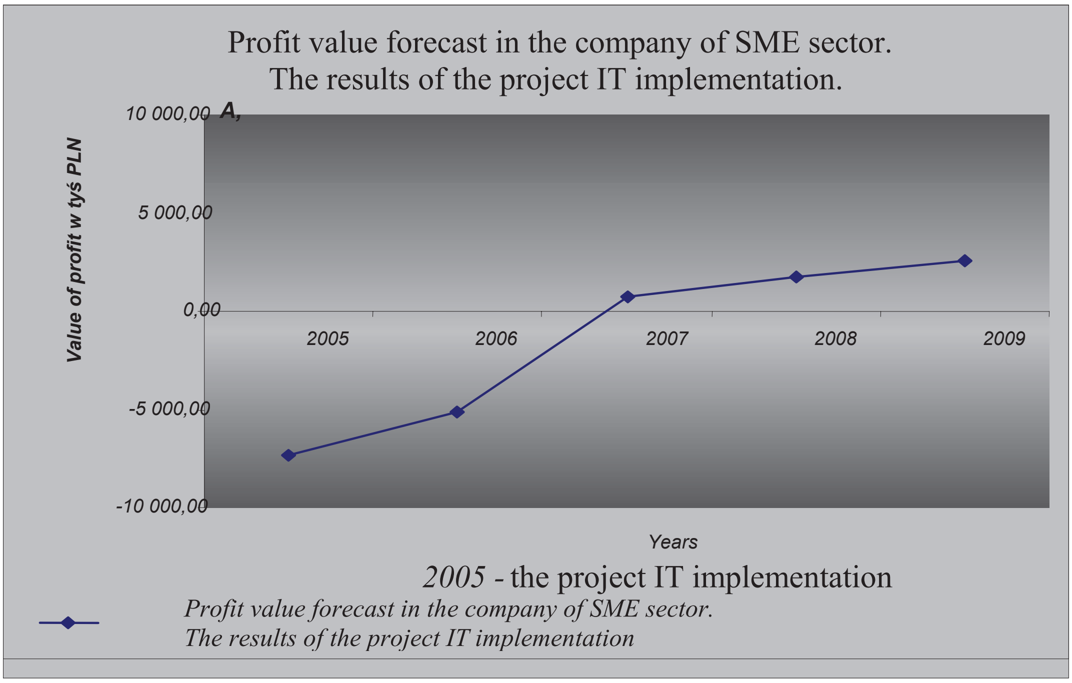

Fig.6. Profit value forecast in the company of SME sector
- the results of the project IT implementation

The decision making model which has been defined enables us to carry out a re assessment of the ERP class implementation. This model is a synthetic indicator of effectiveness that consist of certain particle indicators (u- turn-over profitability value indicator (profit/total capital) , v- profitability value (total costs/turn-over). The precisely defined indicators are ascribed to this model, which allows us to define potential values of these parameters after the system has been implemented. So, on the basis of the data (see Tab.5) the function, which normalize the indicators u, v -assigned to the decision making model, is introduced.

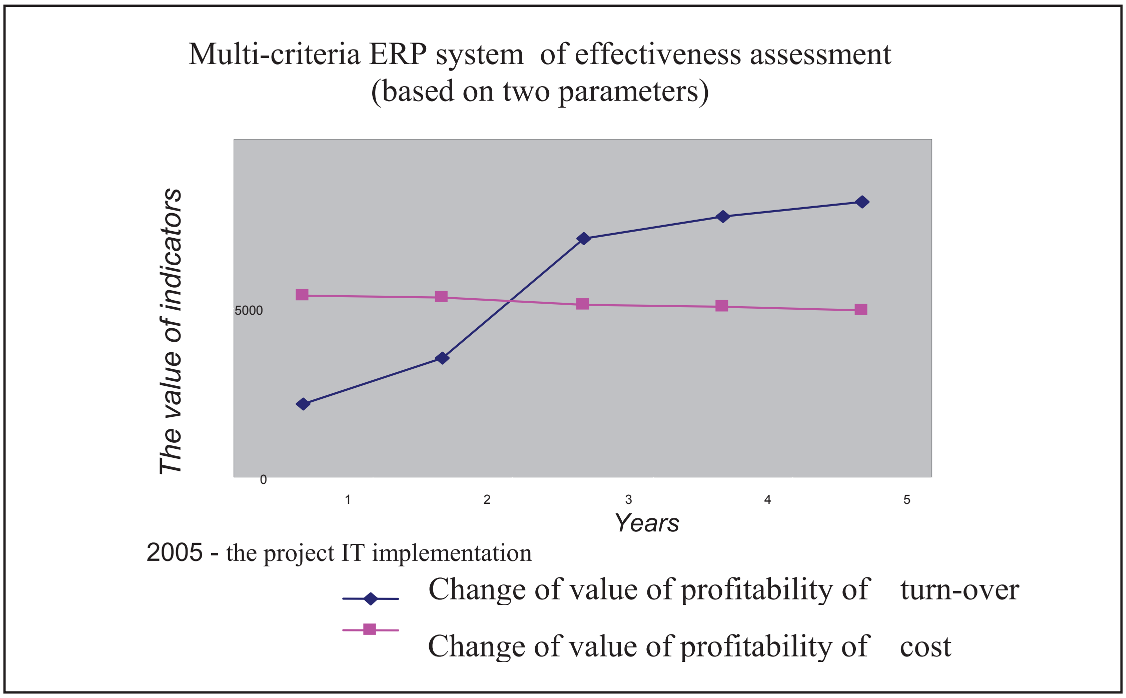

Fig.7. Multi-criteria ERP system of effectiveness assessment
(based on two parameters)

An increase in the turn-over profitability value can be clearly seen and a decrease of costs profitability after the ERP system has been implemented. The results of the diagnosis for the profit value are shown in Chart 4. It is essential to point out that this method does not require any result interpretation because the decision making model (***) includes this mechanism. It is also important that it allows to carry out an objective system effectiveness assessment Decision making model is contracted on the basis of the knowledge data base. It includes a complex information about all the processes which could be observed while the date base was created , so both examples of successful and unsuccessful ERP system implementation are included. So, on the basis of the decision making model a forecast of a defined indicators value is introduced to the company A.{turn-over and cost profitability). As a result, the company A must make a decision as far as the purchase of the ERP system is concerned. This system is defined as Alpha, Cormach Optima CDN, based on value forecasting.

ERP system – implementation effects forecast on the basis of selected indicators it is a hybrid type of experimental planning technique which combines generic method with regression analysis.

The concept which has just been introduced draws upon the the experience of the companies which introduced the system The application of empirical knowledge enabled the application of Iwachnienko as a modeling tool. It made the automatic synthesis possible, which is characterized by high accuracy of estimation. The integration of all the processes in the expert system environment makes it possible to use the genetic observation method as a diagnostic device ,which is a n effective supporting tool.

6. CONCLUDING REMARKS

The procedure which has been introduced in this paper gives more possibilities in the area of profitabilities of the IT projects in progress This approach seems to be, apart from a common calculation of the investment profitabilities, an excellent tool for systems economical analysis he model which has been discussed will be assessed in the research to follow ERP system class is also defined in terms of the similarity of the business support processes The decision making model which has been suggested connects selected factors of SME implementation effectiveness with the characteristics of ERP system and the parameters of the company. Which enables to asses the IT project profitability In consequence this method allows for the evaluation of the system implementation.

The research which is in progress is focused on the development of the SME knowledge database which would be similar in terms of functionality fields as well as defined user's needs. A decisive nature of an undertaken problem imposes the structural model of identification.

References

[1] AL-MASHARI M., AL-MUDIMIGH A., ZAIRI M.: *ERP: A taxonomy of critical factors.* European Journal of Operational Research, 2003, pp. 352-364.

[2] BANASZAK Z., KUŚ. J.: *Group Method of Data Handling in technical diagnostic tasks.* Applied Mathematics and Computer Science, Vol.3, pp. 573-593

[3] FARLOW S.J.: *Self-Organizing Methods in Modeling - GMDH Type Algorithms*. Mersel Dekker, new York, 1984.

[4] FORTUNA Z., MACUKOW B., WĄSOWSKI J.: *Metody numeryczne*. WNT, Warszawa1982.

[5] KACZOREK T.: *Teoria sterowania i systemów*. PWN, Warszawa 1993.

[6] KORBICZ J., OBUCHOWICZ A. ,UCIŃSKI D.: *Sztuczne sieci neuronowe*. Akademicka Oficyna Wydawnicza, Warszawa 1994.

[7] KUMAR V., MAHESHWARI B., KUMAR B.: *Enterprise resource planning systems adoption process: a survey of Canadian organizations*. International Journal of Production Research 2002; vol. 40: 509-523.

[8] LESZCZYŃSKI Z., SKOWRONEK-MIELCZAREK A.: *Analiza ekonomiczno-finansowa firmy*. Warszawa2001.

[9] MOCTEZUMA J.: *Success factors of ERP implementations in manufacturing enterprises*. "Aktualne problemy organizacji i Zarządzania przedsiębiorstwem w warunkach globalizacji", Politechnika Warszawa 2001, s. 105-112.

[10] NIEDERLIŃSKI A.: *Systemy komputerowe automatyki przemysłowej t.II*. Zastosowania, Warszawa 1985.

[11] NIEDERLIŃSKI A.: *Systemy cyfrowe automatyki przemysłowej – Zastosowania*. WNT Warszawa 1977.
[12] NOWICKI A.: *Informatyka dla ekonomistów.* Warszawa-Wrocław 1998.
[13] POHL H-CH.: *Zarządzanie logistyką*. Poznań 1998.
[14] ROSEMANN M.: *ERP – software-characteristics and consequences*. IN Proceedings of the 7th European Conference Information Systems, 1999-ECIS,99, Copenhaven DK.
[15] SARKIS J., GUNASEKARAN A.: *Enterprise Resource Planning – modelling and analysis*. Editorial, European Journal of Operational Research 146, 2003, pp. 229-232.
[16] STOER J., BULIRSCH R.: *Wstęp do analizy numerycznej*. PWN, Warszawa 1987.
[17] TWARÓG J.: *Mierniki i wskaźniki logistyczne*. Poznań 2003.
[18] WOJCIECHOWSKI T.: *Zarządzanie sprzedażą i zakupem materiałów.* Warszawa 1999.