STRATEGIC KNOWLEDGE MANAGEMENT IN SME BASED ON INNOVATION TRANSFER – A CASE STUDY

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ABSTRACT

Added value for SME can be determine as knowledge, employees' skills and abilities, social relation, know-how, and particularly effective investing in intellectual capital. The enterprises which invest in knowledge and systems of work are achieved competitive advantage, because of theirs workers' readiness to learning and qualifying themselves and also thanks to effective information and communication transfers. In this paper we allowed to respond to the following question: whether a given algorithm that enables capital intellectual in SME index and implemented innovations characteristics binding?, Does a given such innovation guarantee to obtain the assumed level of a capital intellectual index in SME for assumed costs and existing limitations or not?. The paper's authors propose to add the model of strategic knowledge management - intellectual capital model - in enterprises based on innovation transfer.

1. INTRODUCTION

The enterprises functioning in market economy have to implement changes in systems of organization and management that they use. In economy practice making a decision in enterprise is conditioned by competitors' action, changing factors of environments, e.g. technical progress and results of the research works. Added value for SME can be determine as knowledge, employees' skills and abilities, social relation, know-how, and particularly effective investing in intellectual capital. The enterprises which invest in knowledge and systems of work are achieved competitive advantage, because of theirs workers' readiness to learning and qualifying themselves and also thanks to effective information and communication transfers.

Decisions by SME as regards knowledge development are always made at a strategic level. It seems justified to combine two management fields into one scientific issue. Knowledge in the paper is understood as improving qualifications and skills among employees by participating in realization of innovative project. As regards research, the status of knowledge includes methods of intellectual capital assessing based on investment of staff's development, transfer of knowledge employees. However, there are no methods assessing the efficiency of decisions on acquiring knowledge based on innovation transfer. The process of managing intellectual capital should consist of two stages: identifying and measuring. Literature distinguishes qualitative measures (e.g. Danish project of IC measurement, 'Scandia' navigator, intengible assets monitor, IC model –TM Rating, VCSTM, balanced result sheet, report by Saratoga Institute) and methods of valuating intellectual capital (e.g. MV/ MB, q-Tobin, CIV, KCE, VAICTM, economic added value, IAV model, Strassmann's method, IAMVTM, technology broker). Attempts are made continuously to create the concept of strategic knowledge management in SME. The difficulty is that the majority of concepts are prepared for specific companies, in other words such measuring methods are tailor made and their general application is not possible.

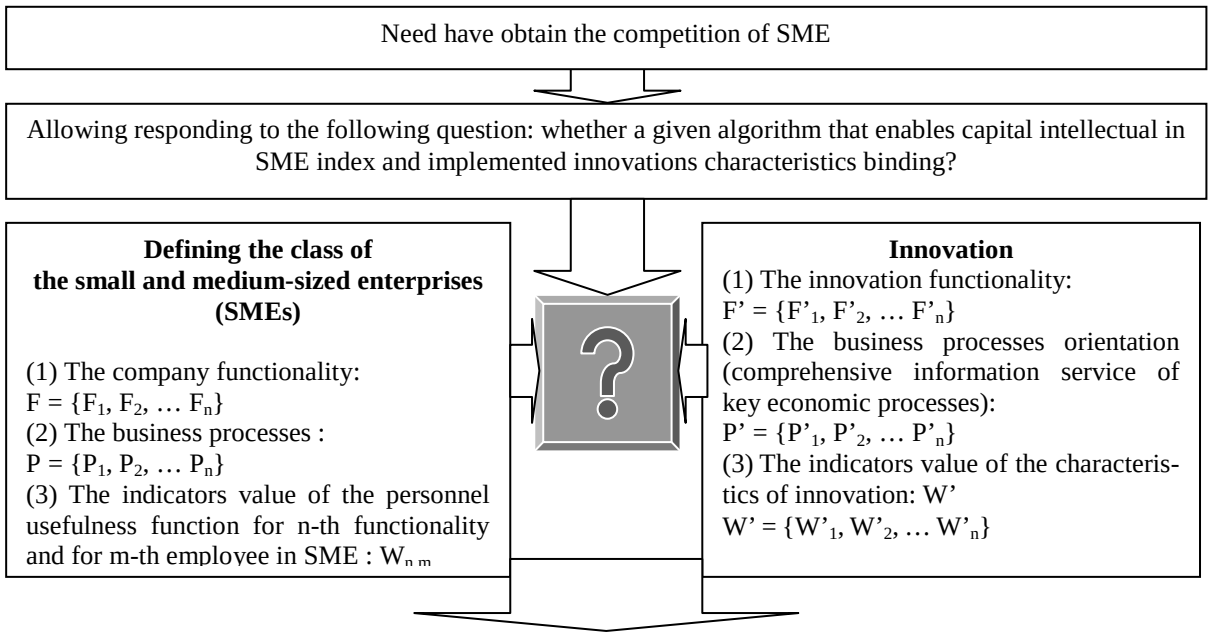
In this paper we allowed to respond to the following question: whether a given algorithm that enables capital intellectual in SME index and implemented innovations characteristics binding?, Does a given such innovation guarantee to obtain the assumed level of a capital intellectual index in SME for assumed costs and existing limitations or not?

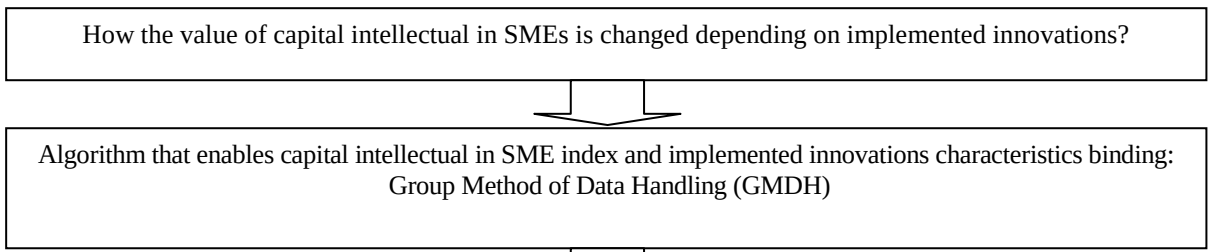
The paper's authors propose to add the model of strategic knowledge management - intellectual capital model in enterprises based on innovation transfer.

2. THE CONCEPT OF STRATEGIC KNOWLEDGE MANAGEMENT BASED ON INNOVATION TRANSFER IN SME

The research and innovations are necessary to create an economic growth and social development. The exchange of knowledge is a basic of market success (synergy effect). Let us present the concept of strategic knowledge management based on innovation transfer in SME (Fig. 1):

Fig. 1 Intellectual capital model in SMEs,
Resource: own elaboration





3. INTELLECTUAL CAPITAL IN SME - THE PERSONNEL USEFULNESS FUNCTION

The specialist literature defines human capital as an element of intellectual capital. According to Leif Edvinsson, intellectual capital in a company is '*knowledge, experience, organisation technology, relations with clients and professional skills, which result in [...] competitive advantage on the market"* [Edvinsson L., Michael S. Malone, 2001]. Human capital, apart from structural capital, is combined knowledge, skills, innovativeness and skills of employees to efficiently perform. Valuation of intellectual capital defines pecuniary value of intellectual capital in a company. Valuation of intangible assets is based on using valuation methods. The value of intellectual capital may be used as complement of traditional valuation of a company, which is usually based on the value of tangible assets.

In the intellectual capital model in SMEs (Fig 1) the personnel SME usefulness function, for each employee and for each defined business process in enterprises, is proposed:

$F(W_{EnPm}) = f(Wo, Wz, Uz, D, Pt, K, O, E, W)$,

where E_n – n-employee in SME, P_m – m-business process in SME, n, m$\in$ N:

- Wo - General knowledge of n-employee for m-business process,
- Wz - Professional knowledge of n-employee for m-business process,
- Uz - Professional abilities of n-employee for m-business process,
- D – Experience of n-employee for m-business process,
- Pt – Patents of n-employee for m-business process,
- K- Clients of n-employee for m-business process,
- O – Personality of n-employee for m-business process,
- E – Absence of n-employee for m-business process,
- W – Salary of n-employee for m-business process.

So, the following personnel SME usefulness function $F(W_{EnPm})$ for n-employee for m-business process in SMEs is developed:

$$\mathbf{F(W_{EnPm}) = f(f_1(Wo),+ f_2(WZ) + f_3(Uz) + f_4(D) + f_5(Pt) + f_6(K) + f_7(O) + f_8(E) + f_9(W)),}$$

where: E_n – n-employee in SME, P_m – m-business process in SME, n, m$\in$ N and

- $f_1(Wo)$ – the general knowledge function for n-employee for m-business process in SME, on set limited A, where: Wo = R, $f_1(Wo) = A = [1,5]$
- $f_2(Wz)$ –the professional knowledge function for n-employee for m-business process in SME, on set limited A, where: Wz = R, $f_2(Wz) = A = [1,5]$
- $f_3(Uz)$ –the professional abilities function for n-employee for m-business process in SME, on set limited A, where: Uz = R, $f_3(Uz) = A = [1,5]$
- $f_4(D)$ – the experience function for n-employee for m-business process in SME, on set limited A, where: D - synthetic index of experience for n-employee in SME for m-business process, binding the factors d_i:

  $D = \frac{\sum_{i=1}^{3} di}{3}$ where d_1 - year of work, d_2 - age of employee, d_3 - number of realized project, $f_4(D) = A = [1,5]$,
- $f_5(Pt)$ – the patents function for n-employee for m-business process in SME, on set limited A, where: Pt - synthetic index of patents for n-employee in SME for m-business process, binding the factors e_i:

  $Pt = \frac{\sum_{i=1}^{4} ei}{4}$ where e_1 - number of patents, e_2 - value of investment of new patents, e_3 – value of copyright, e_4 - number of project, which are waiting for patents, $f_5(Pt) = A = [1,5]$,
- $f_6(K)$ –the clients function for n-employee for m-business process in SME, on set limited A, where: K - synthetic index of clients for n-employee in SME for m-business process, binding the factors k_i:

  $K = \frac{\sum_{i=1}^{3} ki}{3}$ where k_1 - number of all clients, k_2 - - number of permanent clients, k_3 – number of transactions, $f_6(K) = A = [1,5]$
- $f_7(O)$ – the n-employee's personality function for m-business process in SME, on set limited A, where: $O = i(S) \vee j(CH) \vee o(M) \vee p(F)$, where employee's personality: S= R, i(S) = 0 or i(S) = 1; CH= R, j(CH) = 0 or j(CH) = 1; M= R, o(M) = 0 or o(M) = 1; F= R, p(F) = 0 or p(F) = 1 and $f_7(O) = A = [1,5]$
- $f_8(E)$ –the absence function for n-employee for m-business process in SME, on set limited A, where: E - synthetic index of absence for n-employee in SME for m-business process, binding the factors g_i:

  $E = \frac{\sum_{i=1}^{2} gi}{2}$ where g_1 - number of hours of absence of employee on month, g_2 - number of hours of holidays of employee on month, $f_8(E) = A = [1,5]$
- $f_9(W)$ – the salary of n-employee function for m-business process in SME, on set limited A, where: W - synthetic index of salary for n-employee in SME for m-business process, binding the factors h_i:

  $W = \frac{\sum_{i=1}^{2} hi}{2}$ where h_1 - value of salary on month, h_2 - value of extra salary on month, $f_9(W) = A = [1,5]$ [Patalas-Maliszewska J., 2009]

Innovation in this sense will involve an ERP system implemented in a company. Further analysis covers solely companies which implemented ERP because of possibility to obtain data necessary for reporting on investment in intellectual development of employees. ERP systems are tools for improving economic efficiency of SMEs. Modular ERP systems are based on integrated databases containing data describing all activity areas of a company. Examples include Oracle relational databases with inbuilt mechanisms ensuring data integrity.

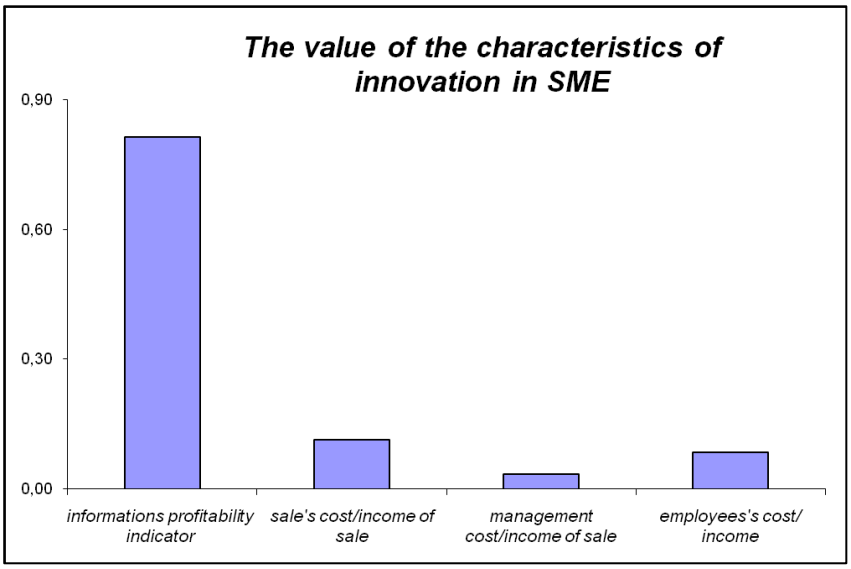
Apart from basic modules in ERP based on an integrated database, that is modules for procurement, production, materials, sales, cost calculation, fixed assets, finance and accounting, new modules are added, such as supply chain management (SCM), Internet supporting techniques ERP (B2B , B2C), company portal (BI), client relation management (CRM), and Workflow Management. Each modul of the sytem performs specific funcitons supporting the activity of a company. The implementation of the proposed concept will enable developing a system supporting decisions on investing in knowledge in SMEs, and consequently implementing IT tools. It is defined the selected indicators values of the characteristics of innovation in SME:

- Information's profitability indicator
- Sale's cost/income of sale
- Management cost/income of sale
- Employee's cost/income

In order to show the possibility of defining intellectual capital model in SMEs: $IC = A_{pq} + B_{pq}x_p + C_{pq}x_q + D_{pq}x_p^2 + E_{pq}x_q^2 + F_{pq}x_p x_q$, that enables capital intellectual in SME index and implemented innovations characteristics, 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.

The values of the characteristics of innovation in SME in 2008 are defined, based on data from ERP system (see Fig. 2).

Fig. 2 The values of the characteristics of innovation in SME in 2008
Source: own elaboration



Consequently the intellectual capital model in small innovative enterprise, based on GMDH method, is proposed.

4. INTELLECTUAL CAPITAL MODEL IN SME BASED ON THE GMDH METHOD

It is presented a model for planning and assessing investment in knowledge acquired by employees in companies.

So, for the enterprise, for the first employee (m = 1) in the production area (n = 1) the value of personnel usefulness function is: $W_{1,1} = 26,67$. Consequently, in the production area in SME:

- for second employee (m = 2), $W_{2,1} = 26,5$
- for third employee (m = 3), $W_{3,1} = 31,33$
- for fourth employee (m = 4), $W_{4,1} = 23,66$

So, the average value of the personnel usefulness function for the production area in the small innovative enterprise: $E(W_{m,1}) = 27,04$ [Patalas-Maliszewska J., Banaszak Z., Kłos S., 2009].

For defined object – the pair: the personnel SME usefulness function, for each employee and for each defined business process in enterprises and the characteristics of innovation was making empirical date of indicators (see Tab. 1).

Table 1 Empirical date of indicators in SME
Source: own elaboration

The characteristics of innovation /intellectual capital	X_1 Information's profitability indicator	X_2 Sale's cost/income of sale	X_3 Management cost/income of sale	X_4 Employee's cost/income
$IC = E(W_{m,1}) = 27,04$	0,81	0,11	0,03	0,09

The data contains the value indicators of SME are based on experience SME where ERP system was applied. The algorithm that enables the personnel SME usefulness function and the characteristics of innovation to be combined was defined as GMDH (Group Method Data Handling), that involves the following assumptions [Farlow S.J.,1984] a precise description of the interdependence between the output and input data (selected characteristics of innovation with the personnel SME usefulness function of the company in which the system was implemented) and minimum modeling error. As a result of the algorithm GMDH implementation the best possible polynomial was obtained which was characterized by the lowest value criteria for regularity assigned to the pair object.

GMDH is an modeling algorithm based on processing empirical data. GMDH was created by linking elements of least squares method and the Gödel's theory, which supplement a procedure for synthesis of hierarchical Ivachnienko's polynominal. The GMDH was initially used for precise prediction of development among fish population in rivers and oceans. The main idea of the algorithm was a synthesis of the polynominal model. Because of the integration of structural and parametriocal optymisation concepts, Ivachnienko's polynominal, resulting from GMDH procedure, turned out to be a model ensuring precision and practical application. The basic assumption of the algorithm was to eliminate a deductive approach based on engineers and experts' knowledge. Another important element was the idea of ploynomnal evolution from its elementary structure to optimised one through selecting various combinations of simple partial models. In the majority of cased these are polynominals second degree with two variables. According to the concept, considering that at each iteration arguments support-

ing the elementary model are polynominal functions consiting of previous iteration, the degree of the resulting polynominal doubles at each stage of the algorhytm. Optimised values of fixed parameters are calculated using the least square method.
GMDH assumptions include the following:

- precise description of relations between input and output data (selected indicators for assessing rationality and effectiveness of investment in knowledge, namely on the one hand investment in human resources and, on the other, effects of investment) in longer term,
- minimising modelling errors.

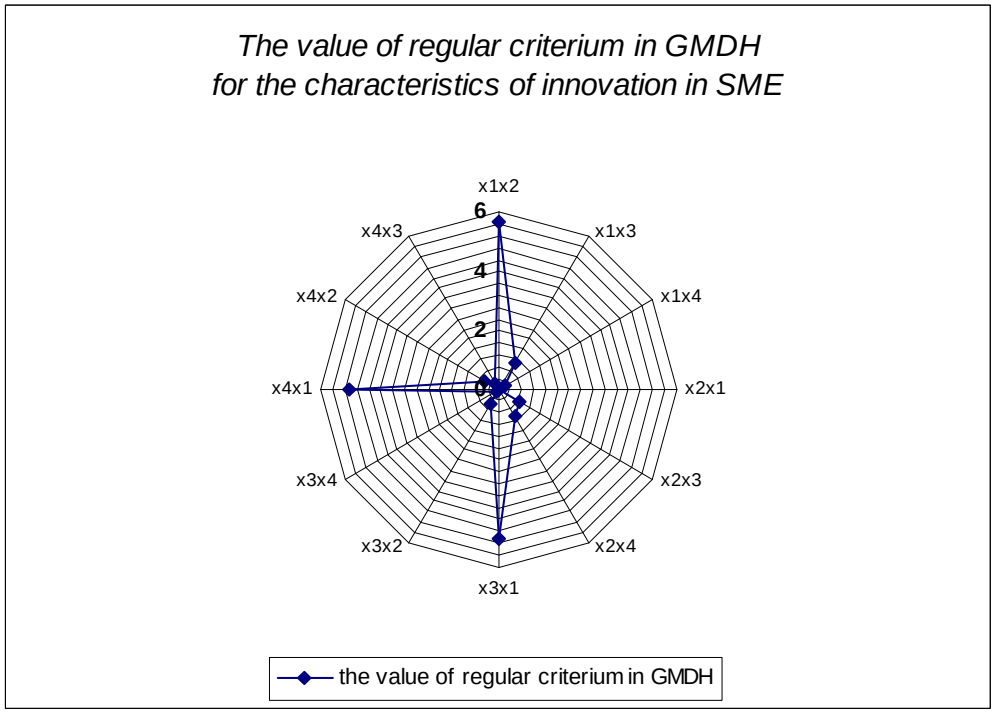
The main problem is responding to the question how the value of capital intellectual in SME is changed depending on implemented innovations – is the presented like the decision problem. In order to illustrate the possibility of answer let us consider the situation: the problem considered regards of the value of personnel usefulness function in the production area and of value of the characteristics of innovation in SME in 2008.

Decision model (intellectual capital model for SME) 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. The application of empirical knowledge enabled the application of GMDH as a modeling tool. In conclusion the decision model, which was under examination, binds the selected characteristics of innovation of SME with the value of personnel usefulness function. This restriction makes the decision making process simple and brings it to some kind of pattern of the restriction propagation. It means that, for some companies, the prediction value of the intellectual capital would bring can be done on the basis of previously defined indicators and the experience of those companies.

As a result of the algorithm GMDH using the best possible polynomial was obtained which was characterized by the lowest value criteria for regularity assigned to the pair object (respectively - the values of the characteristics of innovation in SME in 2008 and intellectual capital as the average value of the personnel usefulness function for the production area). The algorithm evolution process was completed on the second iteration. It is worth pointing out that the second degree of the polynomial was obtained as a result of the implementation of SME and effective operation indicators database. Thus, it can be different from the new characteristics of innovation for effective operation indicators.

In this way, obtaining the smallest modeling error, the polynomial version was selected which is shown in the Fig. 3:

Fig. 3 The values of modeling error using GMDH method
Source: own elaboration



So, the best possible polynomial (decision model), using GMDH method, binding the selected indicators like: X_3 – information profitability and X_4 – employee profitability is defined:

IC (X_3, X_4) = 216,32 X_4,

where X_3 – information profitability, X_4 – employee profitability

This model is a synthetic indicator of effectiveness that consist of certain particle indicators is the polynomial with criteria value **r = 0,0784**

In conclusion the decision model: **IC (X_3, X_4) = 216,32 X_4,**

which was under examination, binds the selected characteristics of innovation in SME in 2008 and intellectual capital as the average value of the personnel usefulness function for the production area. This restriction makes the decision making process simple and brings it to some kind of pattern of the restriction propagation.

The main problem, that involves decision making process, which is understood as a problem of searching of potential value if intellectual capital in SME depending on innovation transfer (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 intellectual capital which would meet the required demands.

It means that, for some companies, the assessment of the IC would bring can be done on the basis of previously defined indicators and the experience of those companies.

5. CONCLUDING REMARKS

In this paper the intellectual model binding the characteristic of innovation, using the GMDH method, has been proposed. It was concluded that on the basis of the decision model the company of SME sector will obtain the prediction of the intellectual capital value depending on the characteristic of innovation.

The concept which has just been introduced draws upon the experience of the company. The application of empirical knowledge enabled the application of GMDH method as a modeling tool. It made the automatic synthesis possible, which is characterized by high accuracy of estimation. It is essential to point out that this concept does not require any result interpretation because the decision model includes this mechanism. It is also important that it allows carrying out an objective system IC assessment.

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 company functionality along with the information bank containing particular database as a result of identification.

The research realization is aimed at new innovative ideas promotion of education and culture in SME and creating a permanent cooperation plane/area between research and developmental sector and business economy. Small and medium – sized enterprises should find a special support for increasing and improving knowledge and innovations as a driving force behind increase to get stable and permanent competitiveness on the market.

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