Volume 1 • Number 1 • May 2010
pages: 21-28

MPER

received: 1 March 2010
accepted: 20 April 2010

# Methodology of Knowledge Value Assessment in an Enterprise of SME Sector*

Justyna Patalas-Maliszewska[1],
Hannes Werthner[2]

*1. University of Zielona Góra, Poland; Technical University of Vienna, Austria*
*2. Technical University of Vienna, Austria*

ABSTRACT

Intangible resources are the source of competitive advantage in the knowledge economy. Knowledge and intellectual capital (IC) within companies have gathered worldwide attention, theories and methods for knowledge creation management have been developed for organizations and alliances. Knowledge has currently become a main part of manufacturing resources and a prerequisite for success in the production environment. The paper develops a theoretical frame of the measurement of IC in the small and medium sizes enterprises based on author's so called personnel usefulness function, which let describe the value of strategic knowledge resources in SME. This study aims to develop the methodology of the measurement of IC, also allows objective assessment of employees through application of GMDH algorithm and regressive polynomial model selection. This paper concludes with a discussion of the implications of the research.

KEY WORDS

**strategic knowledge resources, intellectual capital assessment**

** Within the support of the Community under a Seventh Framework Programme, People, Marie Curie Intra-European Fellowship for Career Development: "SKnowInnov"*

***Corresponding author:***
*Justyna Patalas-Maliszewska*
*University of Zielona Góra*
*Licealna 9 St., 65-417 Zielona Góra*
*Poland*
*tel. +48 607-847-207*
*fax +48 68 327-07-35*
*e-mail: j.patalas@iizp.uz.zgora.pl*

## Introduction

"Intellectual capital means owned knowledge, experience, organisational technology, relations with clients and professional skills which give [...] competitive advantage in the market" [Edvinsson et al., 2001]. According to this concept, intellectual capital includes human capital and structural capital. Intellectual capital can be presented as a group of the following factors:

- features brought by an employee: intelligence, involvement, energy, positive attitude, reliability and honesty,
- employee's ability to learn: mind's power of absorption, imagination, analytical thinking ability and creativity,
- employee's motivation to share information and knowledge: ability to work in a team as well as self motivation to pursuit and achieve goals [Sokołowska, 2005].

Structural capital (also called organisational) encompasses intellectual copyrights, including patents, licenses, trademarks and copyrights.

The concept of human resources encompasses employees of enterprises together with their education, experience, professional qualifications, work performance, interpersonal relationships and communication skills. On the other hand, it needs to be emphasized that employee are not resources but have resources at their disposal, i.e. the total of characteristics embodied in them, which allow playing different roles in the organisation [Pocztowski, 2003, p. 36]. In turn, strategic resources are defined as resources difficult to follow.

In this paper, the concept of strategic knowledge resources is used as an indicator for describing the value of its intellectual capital. The definition of knowledge resources is of valuating importance, pointing out the distinguishing meaning among other resources in enterprises (tangible, financial and informative).

Small and medium – sized enterprises which notice a necessity to planning and reporting about their capital value in the face of market economic globalization, strong and intensified competition, have to choose the right and the most appropriate method (or tool) to assessment of their intellectual capital. Striving to their main aim, which can be improvement of some chosen parameters in specific time, the enterprises need an advisory system to value and forecast their capital, especially intellectual capital.

Based on these considerations the following research problem can be formulated:

There is a given enterprise of an SME sector with defined strategic knowledge resources, in accordance with a defined and accepted reference model. How can we measure its intellectual capital, using this so-called reference model?

The SME model proposed is based on a literature review and own research [Kasprzak, 2005]. It is empirically based on a sample of selected SMEs, focusing on the sales area (in the specific case 10 companies). Business processes were identified in detail for each division of the company. It refers to the definition of SMEs (an SME according to the regulation dated November 12, 1999, Commercial Law – Dz .U .Nr 101, 1178) and includes the following business processes, employees (description of workplaces), and a so called a personnel usefulness function (an indicator for describing the value of its intellectual capital). The business processes in each functional area also contain a description of the respective employees' activities. The personnel usefulness function is defined for each employee, which realize the determined set of business processes.

The paper is structured as follows: in chapter two the notion of intellectual capital and strategic knowledge resources in an enterprise of SME sector are strictly defined. In chapter three author's methodology of the assessment of intellectual capital in SME is presented. In chapter four the example of calculating the values of strategic knowledge resources in a functional sales department is presented and the correlation between measurement of intellectual capital (IC) value and the strategic knowledge resources value is described. Chapter five provides the direction of further works.

## Intellectual Capital and Strategic Knowledge Resource in an Enterprise of SME Sector

Intellectual capital means acquired knowledge, experience, organisational technology, relations with clients and professional skills, which give "[...] competitive advantage in the market" [Edvinsson et al., 2001]. "It is knowledge which can be changed into value" [Jarugowa and Fijałkowska, 2002].

The respect and adoption of each employee's intelligence is the key to continuous company management [Davenport and Prusak, 1998]. Polanyi (1958) divided knowledge into tacit knowledge and explicit knowledge based on the degree of expression. Nonaka and Takeuchi (1995) defined knowledge as a kind of personal characteristic that is too abstract to transfer or even express using words. According to the professional level, Quinn et al. (1996) categorized knowledge into know-what, know-how, know-why and care-why. In the case of strategic human resource management, anticipative capacity building is key to prepare and develop domestic and international cadres of strategic personnel for all sectors—public, nonprofit, and profit [Schein, 1995], [Argyris and Schon, 1988]. Howells (1996) thought that knowledge is a kind of expertise that is not editable. Leonard-Barton (1995) defined knowledge as core endurance. It consists of four factors: solid system, management system, employee skill and knowledge, and value/specification.

Based on reviewed opinions concerning the definition of the intellectual capital, its components are defined as follows:

(1) Human capital: features brought by an employee: intelligence, involvement, energy, positive attitude, reliability, honesty, employee's ability to learn: mind's power of absorption, imagination, analytical thinking ability, creativity, employee's motivation to share information and knowledge: ability to work in a team as well as self motivation to pursuit and achieve goals.
(2) Structural (organisational) capital: intellectual copyrights, including patents, licenses, trademarks and copyrights. It is also organisational ability, including physical systems used to send and store intellectual materials. The following factors are included here: quality and the range of information systems, enterprise's reputation, organizational concept and documentation..
(3) External relations capital – contacts with external entities (suppliers and clients), which are of vital importance for the effectiveness of the enterprises.

It is difficult to describe an unambiguous method of assessment of the value of the intellectual capital in the enterprises. Intellectual capital means also different resources: market (trademarks, customers, distribution channels, made orders etc.), competences (abilities to solve problems), intellectual property (patents, trademarks, copyrights etc.) and infrastructure (culture, processes, database and communication systems) [Ashok, 2006].

The strategic knowledge resources are defined as the indicator enabling to assess knowledge in an SME (personnel SME usefulness function $W_{nm}$ for the m-th employee in the n-th SME) [Patalas-Maliszewska, 2009]:

$$W_{nm} = f_1(Wo) + f_2(Wz) + f_3(Uz) + f_4(D) + f_5(Pt) + f_6(K) + f_7(O) \quad (1)$$

where: n, m∈N, and

- $f_1(Wo)$ – the general knowledge value,
- $f_2(Wz)$ – the professional knowledge value,
- $f_3(Uz)$ – the professional abilities value,
- $f_4(D)$ – the experience value,
- $f_5(Pt)$ – the patents value,
- $f_6(K)$ – the m-th employee's clients value,
- $f_7(O)$ – the m-th employee's personality value.

The linear form of this function $W_{nm}$ for the m-th employee in the n-th SME is chosen because all elements are independent and equally important to assess effectiveness and efficiency of investment in knowledge.

It is possible to receive the value of personnel SME usefulness function $W_{nm}$ for the each functional area in entire n-th company:

$$W_{nm} = \sum_{n,m\in N} Wm \quad /i, \quad (2)$$

where i – number of employees in the each functional area in the n-th SME, n,m,i ∈ N

Small and medium enterprises in an especially flexible way adjust to the market requirements and clients' needs by changing activity's profile, products (services) assortment and by forming work time and activities' forms. So, the concept (Figure 1) may be a reference point in benchmarking analysis. Benchmarking can be internal (comparison of strategic knowledge resources within the enterprise – within a given functional department), competitive (comparison with competitors), parallel measurement (comparison to organisations doing the same or similar activities), basic measurement (comparing main indicator to the indicators of any organisation) [Bramham, 2004, pp. 30-32]. In the accepted methodology, as the last stage, the use of parallel Benchmarking is accepted, for the enterprises consistent with the accepted reference model (see chapter 3).

Based on the literature review and economical practice, we can notice a niche in works on assessment system of IC in enterprises of SME sector. Based on author's function describing the value of strategic knowledge resources (personnel SME usefulness function $W_{nm}$ for the m-th employee in the n-th SME) the methodology of the measurement of IC in SME was formulated.

This methodology can be used for enterprises which agree with the accepted reference model. In this model SMEs the following conditions are formulated:

SMEs consists $F_n$ functional areas: $F_n$, n∈N. In the each area there are n-business processes: $p_n$, n∈N. In the each $F_n$ functional area work m-employees: m, m∈N. Each m-th employee in a $F_n$ functional area can participate in more than one business process.

For each m-th employee in the $F_n$ functional area one can define a personnel usefulness function: $W_{nm}$ for the m-th employee in the n-th SME n,m∈N.

The use of the presented methodology makes it possible to build a database of the values of strategic knowledge resources for a specific group of enterprises (in accordance with the accepted reference model) and as a result it will make it possible to use the benchmarking analysis. As a result, a given SME enterprises will be able to introduce changes and/or suggest new strategy of knowledge resources management.

## Methodology of Intellectual Capital Assesment in Enterprises of SME Sector

The presented procedure of the assessment of intellectual capital takes into account the previously described personnel function, which allows describing the value of strategic knowledge resources in SME – see step 1, Figure 1, and the reporting character of the measurement of IC in an enterprise (among others, IC scorecard or reference indicators presented in the report of Saratoga Institute – see step 3, Figure 1).

The decision model enabling us to:

- define the most important influence the measurement of IC value on the value of $W_{nm.}$
- asses and forecast of IC value in SMEs.

The integration of the measurement of IC and the strategic knowledge resources (see step 4) is a major concern for companies that want to measure their intellectual capital.

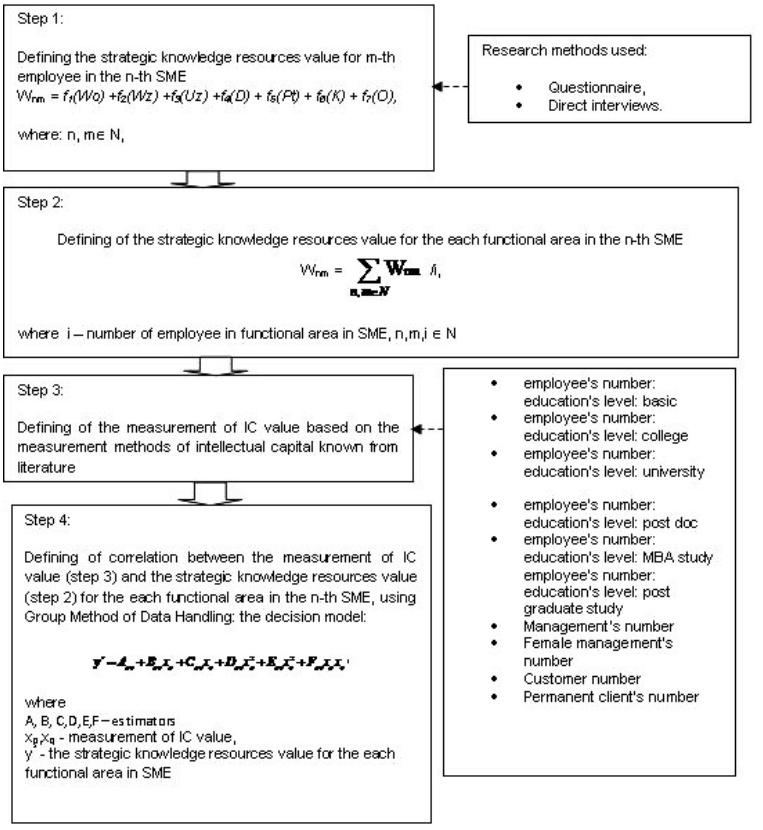


Figure 1.
The procedure of intellectual capital assessment in SMEs

*Source:* Authors elaboration.

We were able to measure and compare the effectiveness of nine different measurement of IC and their influence for strategic knowledge resources value, that are interesting and relevant for theory as well as practice.

We found that housing measurement of IC and the strategic knowledge resources closer to each other and using an Group Method of Data Handling board are the most effective mechanisms to foster integration. The decision model (see step 4, Figure 1) appears to be a very effective tool for enhancing IC value.

## Assessment of Intellectual Capital: Case Study

For the presentation the stages in the procedure of intellectual capital assessment in SMEs is case study on example SME presented. The date which was used in this assessment come from 2006-2008. The data were collected from the company belonged to reference model of SME [Patalas-Maliszewska, 2009].

According with the procedure (Figure 1) is the strategic knowledge resources value for m-th employee in the 1-th SME, for functional area: sale ($W_{1m}$), defined (using the direct interviews) – see step 1, Figure 1. So, for the first employee (m=1) – (sales specialist) the value of personnel usefulness function is created:

$$W_{11} = f_1(Wo),+ f_2(Wz) + f_3(Uz) + f_4(D) +$$

$$+ f_5(Pt) + f_6(K) + f_7(O),$$

where:
- $f_1(Wo) = 3$ (max $f_1(Wo) = 5$) .
- $f_2(Wz) = 4$ (max $f_2(Wz) = 5$).
- $f_3(Uz) = 0$ (max $f_3(Uz) = 5$).
- $f_4(D) = 0$ (max $f_4(D) = 5$).
- $f_5(Pt) = 0$ (max $f_5(Pt) = 5$).
- $f_6(K) = 0$ (max $f_6(K) = 5$).
- $f_7(O) = 5$ (max $f_7(O) = 5$).

and consequently the $W_{11}$ for first employee in the sale area: $W_{11} = 12$ (see step 1, Figure 1)

So, for another employee in the sale area in the 1-th SME is the value of personnel usefulness function created (see step 1, Figure 1):

- For second employee (m=2) – (sales specialist) – $W_{12} = 13$
- For third employee (m=3) – (sales specialist) – $W_{13} = 15$
- For fourth employee (m=4) – (sales specialist) – $W_{14} = 16$

So, the strategic knowledge resources value in the considered enterprises, for the sales department equals: $E(W_{1\,1\text{-}4}) = 14$ according with the step 2, Figure 1.

The value of strategic knowledge resource in the sales department in the considered enterprise is on the level of 40% (maximum value of IC for the given department equals 35, ($\max \sum_{n,m \in N} W_{1\,1\text{-}4} = 35$)

If we want to find out if the result is good for the given enterprises, we need to compare the received result to the value of "sales" department of another enterprise, according to the reference model. Next, we can consider if the present condition of strategic knowledge resource is satisfactory.

Next, according with the procedure (see step 3, Figure 1) the measurement of IC values in the sale area are defined (Figure 2, Figure 3).

The considered enterprises does not have the intellectual property rights, including patents, licenses, trademarks or copyrights, so structural capital was not defined.

Next step involves defining of correlation between the measurement of IC value (Figure 2, Figure 3) and the strategic knowledge resources value ($E(W_{1\,1\text{-}4}) = 14$) – see Stage 4, Figure 1) – the GMDH algorithm is used.

GMDH is an modelling algorithm based on processing empirical data. This alghorithm is chosen, becouse enabling us to define the most important influence the measurement of IC value on the value of the strategic knowledge resources value $W_{1\,1\text{-}4}$ and to asses and forecast of IC value in SMEs.

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 algorhytm 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 algorhytm was to eliminate a deductive approach based on engineers and experts' knowledge. Anothe rimportant 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 supporting the elementary model are

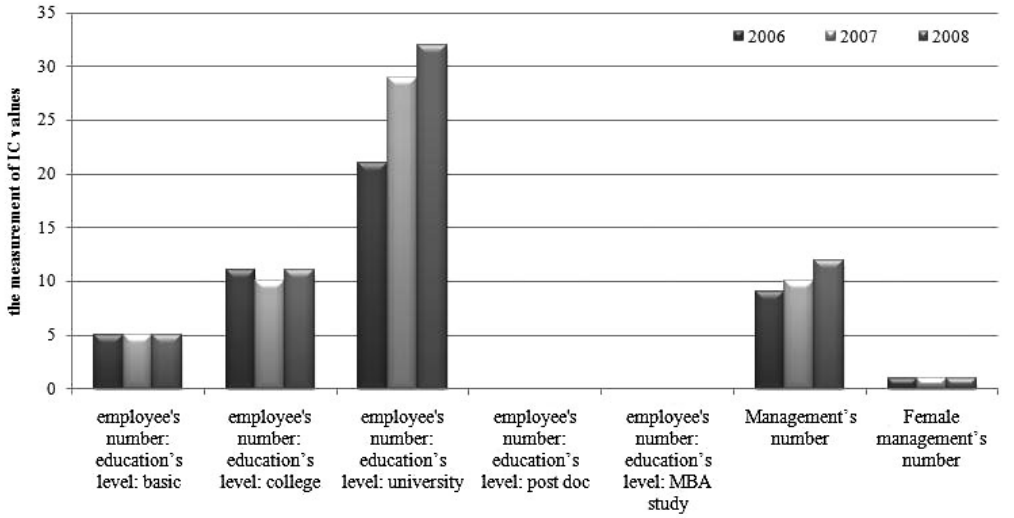


Figure 2.
IC measurement – human capital measurement

*Source:* Authors elaboration.

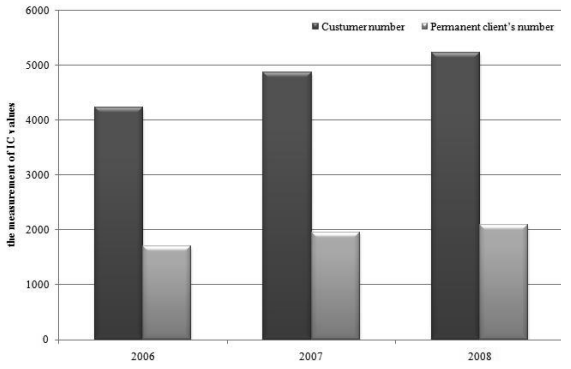


Figure 3.
Figure 2 IC measurement – customer capital measurement

*Source:* Authors elaboration.

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. Many applications, developed after publishing GMDH, confirmed it sefficency and broad application.

GMDH 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 Gödl 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, 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 cannot 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.

So, for the object (SME, functional area: sale) it is presented the output (see figure 2, figure 3):

- $x_1$ – employee's number: education's level: basic – 0
- $x_2$ – employee's number: education's level: college – 1
- $x_3$ – employee's number: education's level: university – 3
- $x_4$ – employee's number: education's level: post doc – 0
- $x_5$ – employee's number: education's level: MBA study – 0
- $x_6$ – employee's number: education's level: post graduate study – 2
- $x_7$ – management number: – 1
- $x_8$ – customer number – 5229
- $x_9$ – permanent client's number – 2091

and one output: $y = E(W_{1\,1\text{-}4}) = 14$.

The model enabling to asses and forecast of knowledge in SMEs – using Group Method of Data Handling:

$$y^* = A_{pq} + B_{pq}x_p + C_{pq}x_q + D_{pq}x_p^2 + E_{pq}x_q^2 + F_{pq}x_p x_q \quad (3)$$

where:
A,B,C,D,E,F – estimators; $x_p$,$x_q$ – measurement of IC value; $y^*$ – the strategic knowledge resources value for the functional area: sale in SME

is created. As a result of the algorithm implementation the best possible polynomial was obtained which was characterized by the lowest value criteria for regularity assigned to the object (SME). 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 measurement of IC value.

In this way, obtaining the smallest modeling error, the polynomial version were selected. Consequently, the best possible polynomial is defined:

$$y(x_3,x_8) = 0{,}00057x_3+0{,}000001x_8+0{,}00057x_3^2+ 0{,}000001x_8^2+0{,}00007x_3x_8 \quad (4)$$

where:
$x_3$ – employee's number: education's level: university,
$x_8$ – customer number.

In conclusion the model, which was under examination, binds the selected indicators of measurement of IC value (employee's number: education's level: university, customer number) with the strategic knowledge resources value for the functional area: sale in SME. The forecast value of the strategic knowledge resources value for the functional area should be 28,45 (on the level of 80% – maximum value of IC for the given department equals 35).

So, the best correlation between the measurement of IC value (Stage 3) and the strategic knowledge resources value for the each functional area in SME is presented for parameters: employee's number: education's level: university and customer number. It means, this parameters are most important in the process of knowledge investing strategy in SME.

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 knowledge investing strategy under examination).

## Summary and Conslusions

In SMEs the accepted practice is the one with direct contact between management and employees, so called informal communication. It often happens that thanks to such contacts, management receives information on problems within the organisation. On the other hand, there might appear problems with personnel assessment.

The presented methodology of the measurement of IC based on the author's function, (which allows describing the value of strategic knowledge resources in SME,) allows an objective assessment of employees. In further works, a database of strategic knowledge resources of enterprises in agreement with the accepted so called reference model will be presented.

Although this approach enabled us to conduct an in-depth study and control for a considerable correlation between strategic knowledge resources and the measurement of IC in an SME, it might limit our ability to generalize our findings. Although this should be the object of empirical verification, we do not see any a-priori reasons why the effects observed would be different in other companies (for example – large sizes company). The actual effects might vary somewhat in size, depending on whether the industry is more strategic resource development oriented instead of IC measurement increase oriented. For example, the importance of integrating mechanisms might be higher in industries where investment in new product development is the dominant activity.

In the research to follow it is planned to build an IT tool for supporting decision making at strategic level as regards profitability of investment in employees' qualifications and skills based on collected data.

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