Methodical Aspects of Knowledge Management in a Contemporary Company

Maciej Malara and Zbigniew Malara(✉)

Faculty of Computer Science and Management,
Wrocław University of Science and Technology, Wrocław, Poland
maciej.malara@pro.wp.pl, zbigniew.malara@pwr.edu.pl

Abstract. The paper presents selected aspects of knowledge management in a company. Components of the knowledge management model were described and the need for their product-based valuation was indicated. Emphasizing the importance of the intellectual capital retention, the principal component analysis method was employed with an intention to use it for the needs of an incentive (rewarding) system.

Keywords: Knowledge management · Intellectual capital
Principal component analysis · Company management

1 Introduction

In the global economy, apart from factors such as raw materials, equipment, machines, finance, energy, land and cheap labour, which determine the competitive capabilities of a company in the traditional economy, additional resources play an important role. They include an intellectual capital, i.e. employees, their knowledge, competences, attitudes and ideas. The creation of this capital requires sophisticated tools and specialists with high competences. Hence, the gathering of knowledge and the ability to use and maintain it seem to be one of the greatest challenges faced by the economy today. In some industries, such as IT, telecommunication, pharmacy, consulting, education, this resource turns out to be so important that managers are looking for methods to determine its value [11, p. 126]. This means that a company has to develop systematic rules and models for knowledge management, which in the modern global economy are the main determinants for the space of freedom for their survival and development as well as an important source of competitive advantage [14]. The previous findings of practitioners and theoreticians of management sciences, which make the knowledge management the main discipline responsible for creating the wealth and employment across all industries, support this thesis [4, p. 140]. Knowledge management, especially in recent years, has been becoming one of the most developed research disciplines, mainly for practical reasons. Knowledge is a goal and a mean to reach the goal. It must be skilfully acquired, explored, exploited and gathered in knowledge bases and employees' minds. Moreover, companies must also demonstrate their capabilities to manage knowledge, including the ability to retain it [2, p. 71].

N. T. Nguyen et al. (Eds.): ACIIDS 2018, LNAI 10751, pp. 71–81, 2018.
https://doi.org/10.1007/978-3-319-75417-8_7

2 Knowledge Management in a Company

Depending on the potential of a company, its current position on the market and strategic intentions, it creates and mobilizes knowledge and competence resources of various degree of significance for the functioning of a company.

The view that the condition for an effective operation of a company is its ability to survive, adapt and develop [6, p. 68] and that the ability to identify the environment and shape the company's activity in accordance with the requirements imposed by it provides a basis for functioning of each company and is the main determinant of its successes [16] has solid grounds in the literature and organizational practice. If we accept this view as correct, it can be concluded that the company should reap benefits from various categories of knowledge. These categories include *basic knowledge* for the needs of rudimental operations, *advanced knowledge* that allows gaining a competitive advantage, and *innovative knowledge* which ensures the position of a leader and is full of solutions that other market participants do not have.

The extent to which companies are able to use their knowledge is determined on the one hand by the abilities to enrich the knowledge possessed and to acquire new knowledge, while on the other hand by the ability to create conditions for the needs of appropriate rationing (distribution) and further maintenance of such knowledge or/and its transfer. This requires both overcoming the barriers in appreciating the importance of knowledge management and creating the conditions for enhancing the ability to bridge the gap between the creation of knowledge resources and their use in the company. Based on a literature query, a list of barriers in knowledge management can be created. These are:

- *incoherence of the management staff*, who in fact thinks only about its position, territory and influences [13], [3, p. 33],
- insufficient use of employees' knowledge [22, p. 33], [15, p. 32],
- information problems and shortage of knowledge resulting from an uneven distribution of knowledge in terms of needs and requirements of all the company's units and employees, which in turn generates problems of an informational nature[1],
- difficulties in acquiring informal knowledge [18, p. 46],
- inadequate organizational culture and a lack of an atmosphere *to share the knowledge openly*[2],
- overestimation or underestimation of the role of technique and technology, especially of the IT infrastructure [16, p. 29],

[1] In order to reduce a deficit of knowledge, the company should, inter alia: acquire knowledge from the environment and adapt it to its needs, e.g. through trade, foreign investments and license agreements, as well as the through the development of own research and the use (development) of experience; *absorb knowledge*, i.e. create conditions for upgrading the qualifications and for intellectual development of employees, for example by training; *transfer knowledge*, that is use new information technologies and provide good access to knowledge resources.

[2] Numerous experiments and research results indicate that this factor plays a fundamental role in the strategic use of skills, information and ideas in employees' minds. A company that wants to achieve successes on the global market should create an organizational culture based on the collective character of the organization, while avoiding solutions based on the individualism.

- useless databases, which should be eliminated basing on the criterion of practical usability [19, p. 29],
- stereotypical thinking that *knowledge means power* [19, p. 30],
- a gap between the concept and the action [21, pp. 11–15],
- rejecting (not taking into account) negative knowledge[3].
- limiting contacts and informal conversations[4],
- limiting to cognitive knowledge[5],
- transferring knowledge through a single medium [21, p. 30].

With regard to the factors conducive to proper knowledge management, apart from acquiring, accumulating, processing and creating knowledge to a possible broad extent, the company must create conditions for its exchange and transfer or retention with the intent to multiply its value (quality) [10].

To meet these requirements, the company's management board should:

- put a considerable emphasis on education and training of employees [9, pp. 99–169],
- continuously develop the intellectual curiosity of employees[6],
- avoid stereotypical thinking[7],

[3] Experience is often a result of errors and failures, but in no case should it be omitted in the process of knowledge creation. That's because constructive conclusions can be drawn from negative experiences. This requires creation of an atmosphere of trust that is conducive to the exchange of informative knowledge about errors and failures.

[4] Synergistic effects are a consequence of regular, intense contacts between employees, which are conducive to the emergence of new, often surprising solutions. The fewer limitations and restrictions regarding forms, topics and content, the more opportunities to transfer useful knowledge. According to H. Simon, no more than 50% of the knowledge needed in a company may result from the planned talks and meetings. The remaining half is provided by unplanned conversations which are not aimed at a specific goal (i.e. Asian organizational culture).

[5] In the knowledge management process, especially at the stages of acquisition and transfer of knowledge, an important role is played by the *willingness* and *motivation* as well as the *instruments* that strengthen them, such as *incentives*, *comforting* in the event of failure, *calling* for perseverance and *indicating* obstacles. This means that cognitive aspects should be combined with motivational aspects, otherwise the effects may turn out incomplete.

[6] It is a good practice for companies to transfer the best solutions from their existing plants to new ones, thanks to which the knowledge about the best solutions worked out in previous production processes by own employees and external specialists working at the construction is used when designing a new plant. The employees, knowing that they are building a new division *for themselves*, are self-motivated for good work. During the work they acquire knowledge about industrial process. Immediately after completing construction works, they are prepared to carry out production tasks. The skills acquired during the construction and start-up of a new division are transferred to a set of key competences of the company.

[7] A common way to fight the *syndrome of uneven distribution of knowledge* is exchange of knowledge resources between divisions, which includes a regular provision of information about the results achieved by one division to all other divisions. These results are then analysed at management meetings in divisions in order to share knowledge on the best solutions with other divisions, based on the results of the analysis. Complex and hard-to-grasp knowledge is passed on with the help of employees (specialists) who are delegated to other divisions in order to communicate and consolidate mental patterns together with it.

- consciously create mechanisms for identifying and developing the factors conducive to appearance of systemic effects of knowledge[8],
- create conditions for collective learning[9],
- create conditions for developing the creativity and innovation as it takes place at RANK XEROX [20, pp. 20–22],
- develop knowledge systems (databases and networks) and rules of their use [20, p. 20],
- manage competences in the field of the company's human resource function as it is done in NUCOR STEEL CORPORATION – an American metallurgical company [23, pp. 11–17].

The K'NETIX network in a French Buckman Laboratory is an example that petrifies the findings of this part of the considerations, illustrating a manner of knowledge management. These are perfectly organized knowledge resources, which can be widely used by employees [1, pp. 415–416].

3 Verification of Findings

Knowledge management in a company can be examined in four dimensions determining the space of freedom for this process[10]:

- *degree of knowledge organization* (codification),
- *intensity* of spreading the knowledge and its renewal,
- *ability* to absorb (use) the knowledge,
- *skill* to retain (maintain) it.

As it appears from the above, a useful instrument that effectively supports the use of the intellectual capital in a company is the development and use of a knowledge system, taking into account those dimensions, in which a requirement to build the loyalty is permanently embedded and without which effective knowledge management will not be possible.

---

[8] Each company has its own, individual knowledge management manner (system). It results, inter alia, from the company's business profile. This means that the knowledge management should be adapted to specific character and needs of a given company. In order to obtain positive effects from the functioning of a knowledge management system, companies pay attention to two main aspects: taking into account their own interests resulting from the strategic direction of their efforts and working on the development of an organizational culture focused on sharing the knowledge and cooperation.

[9] Many various factors are conducive to collective learning. They include mainly cultural ones, such as: creating the right atmosphere for establishing close and direct contacts between employees; getting rid of the culture based on far-reaching individualism; rewarding the employees who willingly share their knowledge with others, and motivating not only individual employees, but also entire teams.

[10] This division was proposed by Zack, who was the first to introduce the concept of the knowledge transfer cycle in a company [17].

A correctly functioning knowledge system supported by a consistent strengthening of loyal behaviours and attitudes of employees requires identification of the premises guiding the employees who decide to stay with the company and work for it for a long period of time. Then, these premises should be used to develop an incentive (reward) system that will allow not only satisfying the expectations of employees and make them stay with the company and work for it with engagement, but will also allow building their loyalty towards the employer and thus preserving the knowledge resources and the intellectual capital. In order to substantiate the thesis formulated in this way, there was presented an experiment carried out by the authors of this study, which allowed identifying the premises that guide the employees when they decide whether to stay with the company.

3.1 The Subject of the Analysis and Presentation of Data

When analysing the literature on the subject, components of the intellectual capital were identified [1] as well as important factors which can significantly affect the development and retention of knowledge in the organization [2]. Based on these factors, the criteria – components of the model of retention and accumulation of knowledge in the company were established. In order to verify the model, data on the American economy from the period of 1995–2015 were collected and used. They are presented in Table 1. The principal component analysis method (PCA) was used in the study, while the calculations were carried out using GRETL statistical software. The criteria were formulated in the following form:

X1 – expenditures on human capital, expressed in average annual remuneration (per capita),
X2 – expenditures on R&D on an annual basis (per capita),
X3 – expenditures on marketing activities (annually, per capita),
X4 – expenditures on PR activities (ratio of annual volume to the total number of business entities registered in the USA),
X5 – annual value of payments of retirement benefits resulting from Social Security (per capita, excluding the 401(k) plan).

All numerical values presented in Table 1 are expressed in thousands of US dollars and in constant prices of 2015.

3.2 Description of Research Tool

Principal component analysis (PCA) is used to determine new variables, a possibly small subset of which will provide as much information as possible about the whole variability in the data set. The new set of variables forms an orthogonal base in the space of features. Variables are selected in such a way that the first variable maps as much variation in the data as possible. After determining the first variable, another one is determined so that it is orthogonal to the first one and explains the remaining variability as much as possible. The next variable is selected in such a way that it is orthogonal to the first two ones etc. The set of vectors obtained in this way forms an

Table 1. Input data of the model

No.	X1	X2	X3	X4	X5	Year
1	44634	24736	42500	5800	8125	1995
2	45524.5	26103	44000	6200	9062.5	1996
3	46415	27599	46700	6900	6562.5	1997
4	48014.5	29129	48000	7300	4062.5	1998
5	49614	31043	50000	7800	7812.5	1999
6	50670	33315	52300	9300	10937.5	2000
7	51726	33868	52000	8700	8125	2001
8	52228.5	33315	55200	10450	4375	2002
9	52731	34293	56400	10800	6562.5	2003
10	53271	34714	59600	11500	8437.5	2004
11	53811	36107	57780	12200	12812.5	2005
12	54795.5	37721	58390	11800	7187.5	2006
13	55780	3955	60410	12100	10312.5	2007
14	55911	41534	60490	13600	18125	2008
15	56042	41137	56020	12700	19375	2009
16	56291	41093	57540	14720	22812.5	2010
17	56540	4211	57770	13200	29062.5	2011
18	56620.5	42049	69530	15700	27187.5	2012
19	56701	43325	70730	14423	28437.5	2013
20	57707.5	44585	73520	16423	31250	2014
21	58714	46277	76440	15370	27500	2015

orthogonal base in the space of features. The purpose of the principal component analysis method is therefore to find a transformation of the coordinate system that will describe the variability between observations in the best way [12].

PCA method maximizes the variance of the first coordinate, then the variance of the second coordinate and the next ones. The coordinate values transformed in such a way are called loadings from generated factors (principal components). In this way, a new observation space is built, in which the initial factors explain the most of the variability. So, the aforementioned operation can be used to understand the structure of the population studied and the nature of the data used. PCA method may be based on a correlation matrix or a covariance matrix created from the input set.

The algorithm in both versions is identical, but the results are different. When a covariance matrix is used, the input set variables with the largest variation in have the greatest impact on the result, which may be advisable, if the variables represent comparable, relatively uniform values. In turn, the use of the correlation matrix corresponds to the initial normalization of the input set, so that each variable has an identical variance at the input (without weights), which may be advisable, if we are unable to ensure the comparability of values of the variables tested.

The PCA algorithm consists of the following steps based on [5]:

– Determination of means for rows

$$\mathrm{u[m]} = \frac{1}{N}\sum_{n=1}^{N} X[m,n] \tag{1}$$

– Calculation of the deviation matrix

$$X'[\mathrm{i,j}] = -\mathrm{X[i,j]} - \mathrm{u[i]} \tag{2}$$

– Determination of the covariance/correlation matrix

$$\mathbf{C} = \mathbb{E}[\mathbf{B} \otimes \mathbf{B}] = \mathbb{E}[\mathbf{B} \cdot \mathbf{B}^*] = \frac{1}{N}\mathbf{B} \cdot \mathbf{B}^* \tag{3}$$

– Calculation of eigenvalues of the covariance/correlation matrix

$$\mathbf{V^{-1}CV} = \mathbf{D} \tag{4}$$

– Selection of eigenvalues (in order to minimize losses in information, the ones with the highest value are selected)
– Determination of eigenvectors

$$\begin{bmatrix} a_{11}-\lambda & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22}-\lambda & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn}-\lambda \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} = 0 \tag{5}$$

– Projection onto eigenvectors

$$y = \begin{bmatrix} y_0 \\ y_1 \\ \vdots \\ y_{n-1} \end{bmatrix} = \boldsymbol{V}^T \cdot x = \begin{bmatrix} v_0^T \\ v_1^T \\ \vdots \\ v_{n-1}^T \end{bmatrix} \cdot x \tag{6}$$

where:

V – matrix of eigenvectors,
x – projected vector,
y – vector in the new space,
N – number of eigenvector.

Each principal component is therefore described by:

- eigenvalue,
- eigenvector,

- factor loadings,
- contributions of variables,
- communalities.

3.3 Presentation and Evaluation of Quality of the Results Obtained

The results obtained with the GRETL statistical processor are shown in Tables 2 and 3. Since there is no single universal criterion for selecting the number of principal components, it is justified to use multiple criteria for this purpose [7, pp. 84–89]:

Table 2. Results generated by the GRETL statistical processor (1)

Principal component analysis			
n = 21			
Eigenvalue correlation matrix			
Factor	Eigenvalue	Share	Cumulative share in variance
1	3.6320	0.7264	0.7264
2	1.0166	0.2033	0.9297
3	0.2193	0.0439	0.9736
4	0.0938	0.0188	0.9923
5	0.0384	0.0077	1.0000

Table 3. Results generated by the GRETL statistical processor (2)

Eigenvalue vectors (component loadings)					
	PC1	PC2	PC3	PC4	PC5
X1	0.154	−0.940	0.227	−0.195	0.051
X2	0.503	0.061	0.450	0.482	−0.556
X3	0.488	0.261	0.088	−0.812	−0.162
X4	0.511	0.128	0.184	0.208	0.804
X5	0.473	−0.166	−0.840	0.166	−0.125

Percentage of Explained Variance. The number of principal components, which a researcher should adopt, depends on the extent to which they represent primary variables, i.e. on the variance of primary variables contained in them. All principal components carry 100% of the variance of primary variables. If the sum of the variances for some first components constitutes a significant part of the total variance of primary variables, then these principal components can substitute the primary variables to a satisfactory degree. It is assumed that this variance should be reflected in the principal components in more than 80%.

Kaiser Criterion. The Kaiser criterion says that the principal components, which we want to leave for interpretation, should have at least the same variance as any standardized primary variable. Due to the fact that the variance of each standardized

primary variable is 1, according to the Kaiser criterion only the principal components with an eigenvalue that exceeds 1 or is close to it are valid.

Scree Plot. The plot illustrates the rate of decrease of eigenvalues, i.e. the percentage of the variance explained. The point on the plot, at which this process stabilizes and the descending line becomes horizontal, is called the end of the scree (the end of downward trend of the information about the primary variables that is carried by principal components). The components located to the right of the end of the scree represent a negligible variance and mostly present a random noise.

In the light of the above criteria, the decision was made to leave the following variables in the model: **X1** (*'expenditures on human capital'*) and **X2** (*'expenditures on R&D'*) as fully representative and crucial for the explanation of the phenomenon. Since a satisfactory result was obtained, the plans to build a synthetic variable were abandoned.

The variables presented above can therefore be firmly considered as crucial for the retention and accumulation of knowledge in a company operating on the American market.

4 Conclusions and Future Work

Knowledge is subjected to processes of identification, acquisition, exploitation, exploration, development and retention – irrespective of the sources, from which a company draws knowledge, the character and characteristics of knowledge, as well as the conditions, needs, manners and skills that determine the possibilities of managing the knowledge. Each phase of this endless process is a part of a knowledge system that requires the use of appropriate tools to assist its management. This means that modern companies, irrespective of their phase of development, have to go a *long way* and overcome many hindrances to switch from a traditional model of managing to a knowledge-based management model[11].

These phases accurately represent the problem that companies have to solve. The results of the research [8, p. 29] form a view that a vast majority of modern companies is still unaware that knowledge can be managed or has no experience or opportunities to do so.

In fact, the following quotation from a study by Zack refers to this situation*: Although there is much talk about linking the knowledge management with the business strategy, in practice this is widely ignored* [8, p. 30]. Finally, it is worth paying

[11] According to the authors of the studies conducted on a group of 423 companies by KPMG Consulting [8, p. 29], in 1999 nearly 43% of companies were in the phase of chaos, i.e. in the basic phase where there is no correlation between the importance attached to knowledge management and the achievement of its goals. The authors of the studies additionally distinguished four further phases of so-called *knowledge journey*, after going through which a company can achieve the excellence in knowledge management. These are: the phase of *awareness*, the phase of *directing*, the phase of *management*, and the phase of *integrated management*. The authors of the studies classified 32.4% of the companies into the first two phases, 9% of the companies—into remaining two phases, while only 1% of companies qualified to the last phase! [8, p. 29].

attention to two further limitations associated with the philosophy of knowledge management in a company. These limitations are associated with the organizational culture and thus with the system of values and the business model applicable in a given company. It seems that the rigid bureaucratic model with a fixed hierarchy and professional specialization is still prevailing, which hinders its diffusion. An additional, important factor limiting the absorption of the idea of knowledge management is the time pressure associated with quick reactions to the changes occurring in the company's environment. On the one hand, employees, especially managers, do not have time to learn and, on the other hand, both groups do not have time to share their knowledge. If we add to these factors also a lack of willingness to share the knowledge and the connivance for leaks of knowledge outside the company, there should be a call for strong leadership, which should also include the responsibility for the protection of knowledge.

Will it be possible to adopt such a concept in the near future? The companies struggling with the global reality must respond to the problem formulated in such a way. Their response must take into account a number of perspectives, including the responsibility for knowledge, definition of requirements for the knowledge management system, and priorities to be adopted when implementing such a system. In other words, regardless of the type, character and degree of advancement (level) of knowledge, the company must continue efforts to multiply (quantity) and enrich (quality) it, as well as work on methods of its protection (retention). Otherwise, the issue of knowledge management in a company will remain a theoretical problem.

References

1. Brilman, J.: Nowoczesne koncepcje i metody zarządzania. Polskie Towarzystwo Ekonomiczne, Warszawa (2012). (in Polish)
2. Drucker, P.F.: Menedżer skuteczny. Wydawnictwo Akademii Ekonomicznej w Krakowie, Kraków (2004). (in Polish)
3. Friedman, M.: The Social Responsibility of Business into Increase Its Profits. Times Magazine, New York (1973)
4. Herman, A.: Zarządzanie wartością przedsiębiorstwa opartego na wiedzy. In: Przedsiębiorstwo przyszłości. Nowe paradygmaty zarządzania europejskiego. Wydawnictwo ORGMASZ, Warszawa (2003). (in Polish)
5. Krzanowski, W.J.: Principles of Multivariate Analysis: A User's Perspective. Oxford University Press, Oxford (2000)
6. Malara, Z.: Restrukturyzacja organizacyjna przedsiębiorstwa. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław (2001). (in Polish)
7. Massart, D.L., Van Der Heyden, Y.: From Tables to Visuals: Principal Component Analysis, Part 2. LC-GC Europe, vol. 18 (2004)
8. Materials of the Conference: Personel XXI wieku, Zarządzanie wiedzą w przedsiębiorstwie. Konferencja Polskiej Fundacji Promocji Kadr oraz Wyższej Szkoły Przedsiębiorczości i Zarządzania im. L. Koźmińskiego, Warszawa (2001). (in Polish)
9. Mikuła, B., Pietruszka-Ortyl, A., Potocki, A.: Zarządzanie przedsiębiorstwem XXI wieku. Wydawnictwo DIFIN, Warszawa (2002). (in Polish)

10. Nonaka, I., Takeuchi, H.: The Knowledge Creating Company. Oxford University Press, Oxford (2005)
11. Obłój, K.: Tworzywo skutecznych strategii. Polskie Wydawnictwo Ekonomiczne, Warszawa (2012). (in Polish)
12. PQStatSoftware Knowledge Repository. Accessed 2 Dec 2017
13. Smith, A.: An Inquiry into Nature and Causes of the Wealth of Nations. Encyclopedia Britannica, Chicago (1952)
14. Strojny, M.: Zarządzanie wiedzą. Wstęp do dyskusji. Personel 6 (2001). (in Polish)
15. Wawrzyniak, B.: Od koncepcji do praktyki zarządzania wiedzą w przedsiębiorstwie. Master of Business Administration 1, (2002). (in Polish)
16. Webber, R.A.: Zasady zarządzania organizacjami. Państwowe Wydawnictwo Ekonomiczne, Warszawa (1994). (in Polish)
17. Zack, M.: Co-evolution. Dynamique Creatrice. Village Mondial, Paris (2007)
18. Zarządzanie na Świecie, no. 2 (2010). (Polish journal)
19. Zarządzanie na Świecie, no. 6 (2010). (Polish journal)
20. Zarządzanie na Świecie, no. 8 (2010). (Polish journal)
21. Zarządzanie na Świecie, no. 12 (2010). (Polish journal)
22. Zarządzanie na Świecie, no. 33 (2010). (Polish journal)
23. Zarządzanie na Świecie, no. 12 (2011). (Polish journal)