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KNOWLEDGE MANAGEMENT OF KNOWLEDGE INTENSIVE BUSINESS PROCESSES WITH PKA METHOD

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Abstract:
In this article we tested a process-knowledge allocation (PKA) method on real knowledge intensive process. PKA method is based on optimal balance between employee knowledge structure and process structural indexes (degree of process lean-ity). We found out that is useful in knowledge intensive processes like new product development (NPD) process to reorganize it with activity cutting principle in such way, that we decrease process efficiency and reach a better knowledge alignment. This "optimal" knowledge alignment will therefore increase in reverse process efficiency again. We named this process optimization procedure as knowledge based process reverse engineering, because the process is decomposed first and then composed again with focus on better knowledge alignment (optimal, if it is feasible).

Keywords: knowledge management, process management, PKA method, NPD process

1. INTRODUCTION

Producing great variety of new products and services is a common point of modern companies, and the dynamics of their change brought by business demands is continuously growing (Doucek, 2004). Almost every totally new product requires adjusted new product development (NPD) process like applying new development method, modified information system, new assets requirement and especially new knowledge requirement. Knowledge requirements of a specific process are aggregated on work positions (Meglic at al., 2009, Green, 1999). From the process management view, the most critical knowledge problems are related on knowledge intensive processes like NPD process, where we are researching and developing unique products or services. From NPD process view we can say that each product change and consequently a process change could change the required knowledge structure of work positions, and therefore current knowledge of employees is no more optimal. We have so called knowledge gap (Kern at al., 2005) and it was the main point of our research: we tried to minimize it with better knowledge allocation. Classic allocation method (Gärtner & Matoušek, 2005)] is searching for optimal solution, where the knowledge structure of a specific work position is matched with the available knowledge structure of employees. It has a criterion that measures the difference between required and available knowledge and its strength. The criterion of optimization function is usually minimal deficit between knowledge requirements of all work positions and actual knowledge of all employees. In case of important knowledge deficit, we make assumption that the work is less efficient. The company usually solves this knowledge gap and increases efficiency of the process with additional education of employees or it recruits a new employee that has a required strength of required knowledge. We set two questions: if this classic knowledge allocation method is useful for properties of NPD process and if the company has other management option besides buying a missing knowledge with a new employee? Typically, this action generates additional recruiting costs.
First, we looked at the theory of business process management (BPM) (Sheer & Nuttgens, 2000). Regarding to the process indexes, the process will be most efficient if all activities of the process will be performed by the same work position and consequently by one employee (Valiris & Glykas, 2004). This is explained by reducing waiting times of the process flow that they occur between each change of work position. The theory stands for application when the business process has a small number of process activities and it has a stable process path (standard process). In the theory of NPD process, the process is large and complicated due to large number of new unique activities and new required knowledge types. In our case of NPD process, we had 32 process activities. That means that one employee was not capable from knowledge view to perform all process activities. Activities were assigned between many work positions (each work position had its own knowledge requirements). It means that the allocation method must be flexible enough to handle constant changes of NPD process. This is the first problem of classic allocation method, because it requires stable structure of activities in the process, work positions and employees.

The answer on the second question lies in a process output quantity (Anupindi, 1999). Having only one “super” knowledge employee on NPD process and therefore only one work position that could perform all its activities is not applicable because we could have many unique products to develop at the same time. The theory of better process efficiency with minimization work positions changes says, that the duplication of output quantity means searching for another “super” knowledge employee that must cover the whole NPD process. And this has great impact on higher labor costs because “super” knowledge people are expensive. We found a solution in assigning process activities between work positions with simple knowledge and on work positions with complex knowledge requirements. By the nature of NPD process, all simple or all complex activities are never together in terms of process flow sequence and resolving this problem means decreasing NPD process efficiency.

Therefore we need a method that is able to measure a process inefficiency while searching for better allocation of current knowledge of employees, until the NPD process is so inefficient that is better to add a new employee with required knowledge into a process.

2. METHOD

We developed process-knowledge allocation (PKA) (Roblek at al., 2011) method. It is based on assignment problem (Kolman & Beck, 1995) and assumes that we have *n* employees and *n* work positions. This optimization problem is classified as a linear integer problem and could be solved with a simplex optimization algorithm. The mathematical model for this problem (1) is not very useful for

practical use but it is good for explanation of our PKA method. The criterion for the value of c_{ij} (that means the increment of the value if employee *i* occupies work position *j)* is represented as ability of employee to perform work on a specific work position.

(1)

$$Max \quad z = \sum_{i=1}^{n}\sum_{j=1}^{n} c_{ij}x_{ij}$$

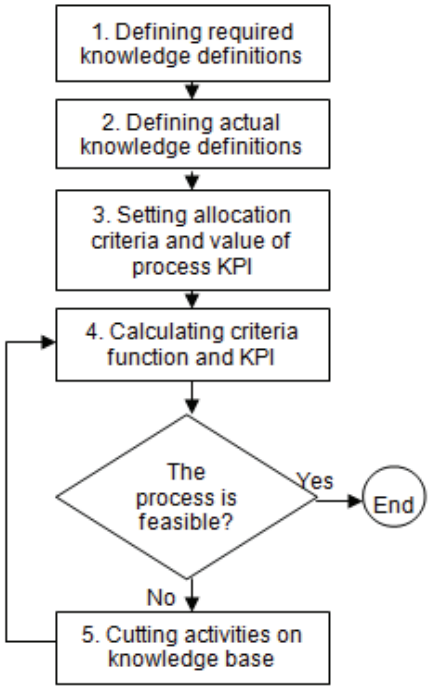
This model assumes that the value of criteria function is presented as a maximization of profit. In our PKA method the model is adopted so that measures the difference between required and actual knowledge and that the criteria function is minimized. It measures also inefficiency in a process, where activities are not stable (as it is in NPD process). It does this with process key performance indicator K_{wpc} (Bauer, 2009) which measures the number of work position changes during the process flow:

(2)

$$K_{wpc} = \frac{C_{wp}}{P_a} \cdot 100$$

In (2), P_a represents a number of process activities and C_{wp} represents a number of work position changes. In a process of *n* activities we can have maximal of *n-1* work position changes. The value of K_{wpc} must be as low as possible if we want efficient process. All steps of PKA model are presented on picture 1. Original PKA method was first created for repetitive processes. We modified PKA model so that it works according to additional features of NPD process.

Picture 1: PKA method

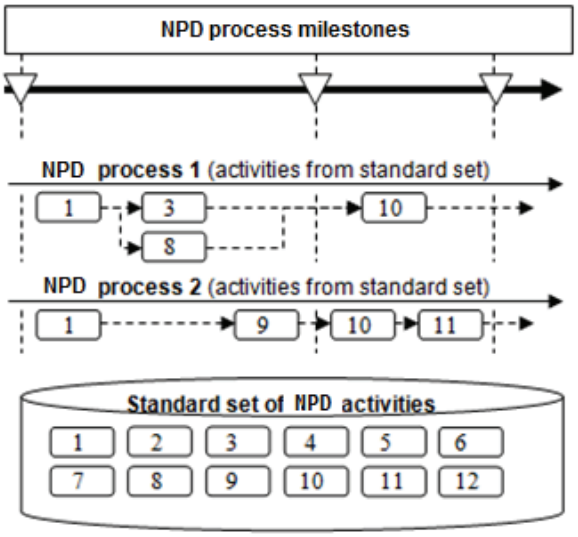


Source: Roblek at al., 2011

2.1. PKA step 1 - Defining required knowledge definitions

The first step of original PKA method was modified because NPD process has no stable set of activities. As shown on picture 2 we created each NPD process from set of standard NPD activities. Each NPD process must follow NPD process milestones.

Picture 2: Relations among NPD process milestones and NPD activities



Now we followed original method steps (Picture 1). We received required knowledge definitions from the standard set of NPD activities. Each variant of NPD process is structured from this set of activities. Than we asked company experts which knowledge is important to have, that the work of a specific standard NPD activity a_i is well performed and of what strength it must be (on a scale from 1 to 5). That means that knowledge requirements of a specific work position represent knowledge requirements of all activities from all NPD processes. Therefore, the employee must have all this knowledge of a specific work position if we want that her/his work will be well performed from aspect of all NPD process variations where he/she is involved. If a specific knowledge of a work position is required on many activities and of different strength, we used knowledge maximal strength. In addition, a specific work position could have a long list of required knowledge and a lot of them with insignificant strength. We created a simple criterion for a definition of key knowledge of a specific work position: key knowledge has strength higher than an average strength value of all required knowledge of specific work position, plus its standard deviation. That means that among all required knowledge we used only best ranked required knowledge.

2.2. PKA step 2 - Defining actual knowledge definitions

We get actual knowledge from company employees. We used 360° feedback method (Maylett, 2009). Each employee was assessed on basis of required list of knowledge (known as explicit knowledge) and their strength on a scale from 1 to 5. We were searching also for her/his tacit knowledge, because in NPD process is important that we have database of all actual knowledge for future NPD process needs or variants. In that way we received knowledge profiles of all employees. Then we measured the difference between required knowledge of a specific work position and actual knowledge of each employee. If employee strength of specific knowledge was over required when compared with work position knowledge strength, then the employee was appropriate. Opposite, when it was below then the employee was inappropriate for that work position.

2.3. PKA step 3 - Setting allocation criteria and target process KPI

In our application we used optimization criteria of best allocation of company available employees on all work positions according to minimal knowledge deficit/surplus (absolute) gap. First, we defined that both, having over knowledge employee on non-difficult work position and having “below” knowledge employee on a very difficult work position is inappropriate. Then we put this definition into the classic assignment problem (1) and we formed the definition (3) of c_{ij} for optimization function:

$$c_{ij} = \sum_{i=1}^{n} \frac{|\Delta K_K|}{n} \quad (3)$$

We interpret this: each employee *i* is compared to each work position *j* on basis of an absolute average knowledge difference K_K of all key knowledge of specific work position. Searching for maximum from original classic model was changed to a criteria of minimal knowledge absolute gap. We used criterion explained on equation (2) as a process key performance indicator (KPI).

2.4. PKA step 4 - Calculating criteria and target process KPI

In this real case demonstration we transferred NPD activities and work positions from MS Project to Aris (Davis, 2008) information tool and formed database of all NPD process activities, actual knowledge definitions, required knowledge definitions, ΔK_k and project KPI calculations. Then we solved optimal solution with WhatsBest (Lindo Systems, 2007) information tool. WhatsBest tool uses a Simplex algorithm for a calculation of optimal solution according to criteria function

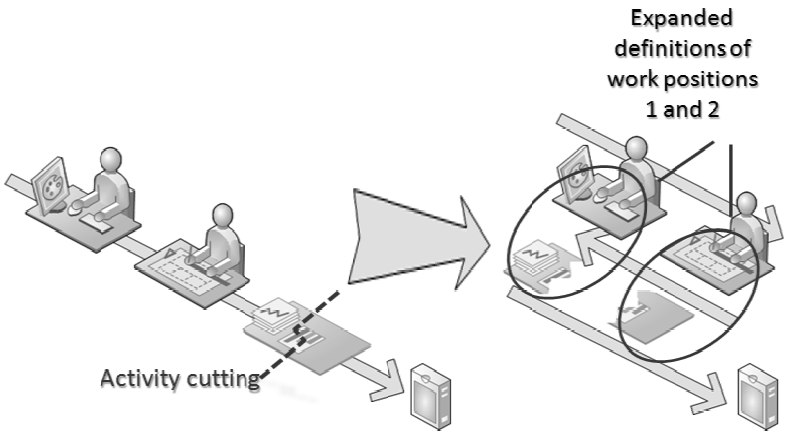
2.5. PKA step 5 - Cutting activities on knowledge base

This is the main part of PKA method. We cope with different limitations in real business when we are searching for a new "actual" knowledge e.g. the management is without budget in a situation of recession to cover employment of "new knowledge". In such case, we re-organize employees on NPD process activities. The problem occurs, because typically we have only a few wide educated employees and a lot of specialists in the NPD process. From the knowledge view wide educated employees are never "bottle necks", but from capacity view they are always. PKA model answers: when there is a lack of knowledge in the process, re-organize it. We defined two steps for implementation of PKA method on NPD process:

1. Find knowledge in the work position that a specific employee is unable to perform, and remove it so that the project activity (or part of it) is removed from work position. When we "cut" a specific activity, the efficiency KPI of NPD process is going worse.
2. Removed part of activity with required knowledge is given to employee that covers it successfully from the knowledge aspect. This means that the knowledge of specific work position has changed (or we created a new work position). Consequently, the knowledge is better allocated (best minimum of z optimization function) and the efficiency of NPD process has been improved.

On picture 3 is a simplified demonstration of cutting NPD process activities on knowledge base. We have NPD process with three activities and their required knowledge (As-Is process). We demonstrated that the performer of the third activity has left the NPD process. Now, we have many possible solutions: to cut and assign third activity to the first and to the second employee, or to cut second activity and assign it to the first and to the second employee, or we can reach better knowledge alignment and better KPI with other possible combinations.

Picture 3: Activity cutting principle



By using this principle, we achieved better actual knowledge allocation by cutting as-is activity on two parts. Of course, we slowed down the process too by doing that because of one additional work position break, but the result was better knowledge alignment and this speeded up the process again. The NPD process has been reorganized on knowledge base, and we called this principle as knowledge based process reverse engineering (To-Be process).

3. RESULTS

We tested PKA method on knowledge intensive NPD process of Telecommunication Solutions Company. We used three work positions: Product manager, Project manager and Functional manager. Due to pages limitation in this article we will show only the input data: variables, optimization function and boundaries functions (4) and calculated knowledge card of one employee (Picture 4). The value of each variable in optimization function is explained with formula (3) as a comparison of employee actual knowledge strength and required work position knowledge strength.

(4)

$$Z_{min} = 0{,}3x_1+0{,}7x_2+1x_3+1{,}8x_4+0{,}5x_5+0{,}8x_6+2x_7+0x_8+1x_9$$

Where:

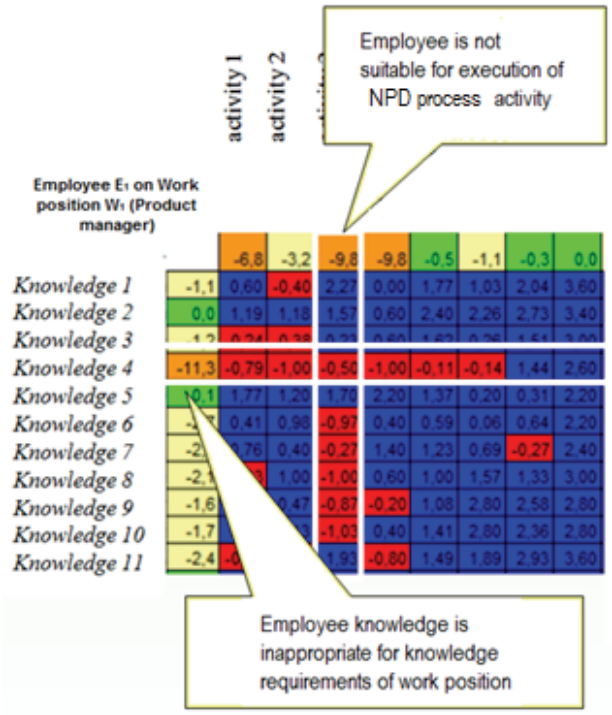
$x_1 = E_1$ occupies W_1
$x_2 = E_2$ occupies W_1
$x_3 = E_3$ occupies W_1
$x_4 = E_1$ occupies W_2
$x_5 = E_2$ occupies W_2
$x_6 = E_3$ occupies W_2
$x_7 = E_1$ occupies W_3
$x_8 = E_2$ occupies W_3
$x_9 = E_3$ occupies W_3

Boundaries functions:

1. E_1 can occupy: $x_1+x_4+x_7=1$
2. E_2 can occupy: $x_2+x_5+x_8=1$
3. E_3 can occupy: $x_3+x_6+x_9=1$
4. W_1 must be occupied: $x_1+x_2+x_3=1$
5. W_2 must be occupied: $x_4+x_5+x_6=1$
6. W_3 must be occupied: $x_7+x_8+x_9=1$

The optimal solution of problem (4) is reached (the knowledge gap is still 1.1 points) when employee E_1 occupies work position W_1, E_2 occupies W_3 and E_3 occupies W_2. Now we can make activity cutting (already explained in the beginning of this section) to find lower value of optimization function with parallel calculation of process KPI for a control purpose that NPD process is still efficient enough. Below is an example of employee card (Picture 4) of matching her/his knowledge on work position required knowledge.

Picture 4: Matching actual employee knowledge on knowledge requirements of work position



4. DISCUSSION

By using PKA method we have an option to have feasible NPD process even when best educated employees are leaving the company. We can substitute them with the knowledge of two or more employees simply by cutting activities. This is especially important for large companies where employee on a specific work position performs many different activities with different knowledge requirements and also in the companies where the fluctuation of employees is high.

Our mission in this research was not to find what value of process KPI is still appropriate. We assumed that the company must follow a best practice of process organization and according to that it defines appropriate process KPI values.

PKA method was previously tested on iterative processes [Kern at al., 2006, Kern at al., 2008). We got an idea that it will be interesting how this model works (if) in knowledge intensive processes. Therefore we adopted and tested PKA method in Slovenian Telecommunication Solutions Company. We built process repository in ARIS tool. It includes all activities with required knowledge, attached work positions, and definitions of all employees with actual (explicit and tacit) knowledge. This is not enough for statistical evaluation of PKA method. But the company feedback shows us that the optimistic results were achieved when:

- Management performed a strategy of company downsizing (and ensured the same quality of output product).
- The company can also better allocate and manage employees that are bottle necks from the process knowledge view, e.g. to eliminate administrational parts of activities from knowledge intensive “bottleneck” work positions, and saves their time for doing product innovations.

5. CONCLUSION

We found, that it is useful to decrease efficiency in knowledge intensive processes in a meaning of structural process indexes (or KPI) to some level to reach a better knowledge alignment with employees and consequently increase process efficiency again. We know that the PKA method is not the only tool for managing knowledge intensive processes (Meglic at al., 2009). However, it helps us optimize process in a relation to required knowledge. Currently we are working on replacement of linear programming for allocation of actual and required knowledge with fuzzy logic. Fuzzy logic will bring a human softness of decision making into PKA method.

REFERENCE LIST

1. Anupindi, R., Chopra, S., Deshmukh, S.D., Van Mieghem, J.A., Zemel, E. (1999). *Managing Business Process Flows*. Prentice Hall, New Jersey.
2. Bauer, K. (2004). *KPIs: Not All Metrics Are Created Equal*. DM Review, 14(12), p. 42., from ProQuest Computing database. (Document ID: 750265451), Retrieved February 19, 2009
3. Davis, R. (2008). *ARIS Design Platform: Advanced Process Modelling and Administration.* Springer Verlag, London.
4. Doucek P. (2004). *IC/ITC Security management in information Society*. ECON’04 – Selected research papers, University of Ostrava. Ostrava (pp. 67-74).
5. Gärtner, B., and Matoušek, J. (2006). *Understanding and Using Linear Programming*. Springer, Berlin.
6. Green, P.C. (1999). *Building Robust Competencies, Linking Human Resource Systems to Organizational Strategies*. Jossey Bass, Inc.Publishers, San Francisco.
7. Kern, T., Roblek, M., Mayer, J., Urh, B. (2005). *Business processes and human resources competence profiles*. IRMA, Idea Group. San Diego, California, (pp. 1202-1204).
8. Kern, T., Roblek, M., Urh, B. (2006). *Analysis of MORS processes, organization and personnel systemization*. Project CRP M5-0048, Ljubljana.
9. Kern, T., Roblek, M., Urh, B., Kokalj, S. (2008). *Development of MORS model for a selection of candidates for special tasks execution*. Project CRP M5-0171, Ljubljana.
10. Kolman, B., & Beck, R. (1995). *Elementary Liner Programming with Applications*. Academic Press.
11. Lindo Systems. (2007). *What’sBest software for Microsoft Excel*
12. Maylett, T. (2009). *360-Degree Feedback Revisited: The transition from development to appraisal, Compensation & Benefits Review*. SAGE Publications, September/October *41*(5), 52-59.

13. Meglic, J., Kern, T., Urh, B., Balkovec, J., Roblek, M. (2009). *Influence of polyvalence professionals on product development process efficiency*. Strojarstvo, *51*(2), 105-121).
14. Roblek, M., Zajec, M., Kern, T. (2011). *The Lack of Knowledge? Change the Way you Work*. Proceedings of the Forty-Fourth Hawaii International Conference on System Sciences HICSS-44, Kauai, HI. Los Alamitos, CA: IEEE Computer Society Press
15. Roblek, M., Kern, T., Zajec, M.(2012). *Knowledge management of the new product development process with process-knowledge allocation model*. V: The 6th IEEE International Conference on Management of Innovation and Technology, 11-13 June 2012, Sanur Bali, Indonesia. ICMIT 2012 : proceedings, (pp. 214-219).
16. Sheer, A.W., and Nuttgens, M. (2000). *Business Process Management: Models, Techniques and Empirical Studies, ARIS Architecture and Reference Models for Business Process Management*. Springer-Verlag, Berlin.
17. Valiris, G., & Glykas, M. (2004). Business analysis metrics for business process redesign. *Business Process Management Journal*, *10*(4), 445-480).