COMPETENCY MAPPING AND MODELLING IN SYSTEM DESIGN[*]

H. Brožová, T. Šubrt

Czech University of Life Sciences, Faculty of Economics and Management, Department of Operational and Systems Analysis, Prague, Czech Republic

The term competence was firstly used in 1959 in describing personal characteristics associated with job performance and motivation. Nowadays it is possible to distinguish three basic terms: competence, competency, and core competency. These terms commonly include the sum of success factors and characteristics necessary for achieving important results in a specific role of a person or an organization in a market environment. Analysis and assessment of competency begins with job competency mapping or individual competence mapping and continues with competency modelling. In this paper we will deal with Competency System Design, which represents the system approach to competency problem solving. This process uses competency maps and models. Reality analysis can have a form of competency map and competency prescriptive model. Normative competency model for the best person selection is the core of the modelling phase. When failure occurs, the metamodelling process creates a competency metamodel to redefine the competency profile.

individual competence; job competency; competence mapping; competency modelling

INTRODUCTION

Competence and competency as basic terms are used by researchers in many fields and from different points of view. The term competence describes personality characteristics associated with education, knowledge, skills and behaviour and competency needed for the best performance and motivation in job positions. The current meaning of this term has been defined by the psychologist M c - C l e l l a n d (1973). Thus we can distinguish three basic terms: competence, competency, and core competency (W h i t e , 1959; M c L a g a n , 1997; D e l a m a r e , W i n t e r t o n e , 2005). The first term is relevant with individual competence, the second explains a set of job competencies and the third the firm competency, firm excellence and individuality.

There have been also attempts to develop standards or normatives of competencies (B a s s e l l i e r , B e n b a - s a t , 2004; L i n t o n , J a y a r a m a n , 2005) desired for given job positions. Because problems related to competency standards are rather complex, the system approach, especially the soft system approach and metamodelling, is a key issue in successful mapping and modelling of competency.

The Competency System Design of the personal competence and necessary job competency are important for solving different types of competency problems. For the description, standardisation and development of necessary competencies, competency maps as well as competency models have proven to be extremely useful tools.

MATERIALS AND METHODS

Competence and competency

The term **competence** was used for the first time in 1959 (White, 1959). It was used to describe personal characteristics associated with job performance and motivation. The modern concept of competencies has been formulated in the work of the psychologist M c C l e l l a n d (1973). Thus we distinguish three basic types of competency:
• Competence,
• Competency, and
• Core competency.

Some authors do not differentiate between the terms competence and competency, but for instance R o w e (1995) and S m i t h (1996–2007) use the term competence for individual skills and performance as the ability to perform some specific action.

While **competency** can be defined as a standardized requirement for an individual to properly perform a specific job, it encompasses a combination of knowledge, skills, and behaviour utilised to improve performance. More generally, competency is the state or quality of being adequately or well qualified, having the ability to perform a specific role. A competency is an area of knowledge or a skill that is crucial for producing key outputs (M c L a - g a n , 1997).

A competency-based approach towards human resources management (HRM) is one of the key success factors in modern organisations. A manager should always bear in mind that the definition of competency is funda-

mental in all HRM activities – starting with recruitment, through training, assessment, and development. Competencies are more than just characteristic of a person; therefore, competencies can be defined as knowledge, skills and attitudes, commitments or values that are necessary for a specific position.

Garrett (2003) uses the following three-point definition of competency:

- A title,
- A brief high-level definition,
- One or more key behavioural statements.

Competencies are the basis of human resource management in any modern organisation. Their function is typically expressed as a competency model. Gliddon (2006) describes the competency model as a description of:

- Knowledge,
- Skills,
- Capabilities, and
- Behaviours.

These are required to successfully perform any job or function. An organization may use a competency-based system as a business strategy to determine how competency models are functionally and multi-dimensionally used for:

- Hiring and selection,
- Assessment,
- Performance management,
- Training and development, and
- Career development (McLagan, 1997).

Core competency is the third important term. It should be distinguished from the common term competency. Core competency is a key organizational resource that may be exploited to gain competitive advantage (Delamare, Wintertone, 2005) and is directly related to organisational aspects. Core competency is the key aspect of the competitivity of an organisation as well as individuals and creates a sustainable competitive advantage for a firm in the market environment (Rothwell, Lindholm, 1999). According to Hamel and Prahalad (1990) and Mascarenhas et al. (1998) core competency represents the firm's specific activity and can include product development, different technical matters, the firm's reliable processes, know-how or relationships between the firm and its surroundings. Core competency is closely related to technical or product approaches (Smith, 1996–2007). It should meet the following three criteria:

- Provide customer benefits,
- Be hard for competitors to imitate,
- Be leveraged widely to many products and markets.

In modern firms activities that are not part of a company's core competency are usually outsourced.

Competency mapping and modelling

Competencies include the sum of success factors necessary for achieving important results in a specific job or work role in a particular organization (Garrett, 2003). These attributes or factors include: personal char-

acteristics, traits, motives, values or ways of thinking that impact an individual's behaviour. Analysis and assessment of competency begin with job competency mapping or individual competence mapping and continue with competency modelling. Competence, competency mapping and modelling generally serve to structure a personal competence/y or to construct a job competency.

- **Competency map** (Garrett, 2003): A competency map is a list of an individual's competencies that represent the factors most critical to success in given jobs, departments, organizations or industries that are part of the individual's current career plan. Competency mapping is a process an individual uses to identify and describe competencies that are the most critical to success in a work situation or work role.
- **Competency model** (Lepsinger, Lucia, 1999): A competency model is a descriptive tool that identifies the skills, knowledge, personal characteristics and behaviours needed to effectively perform a role in the organization and help a business meet its strategic goals.

Job competency mapping is a process of identifying key competencies for a particular position in an organisation, and then using it for job-evaluation, recruitment, training and development, performance management, succession planning, etc. (Pagey, D'Silva, 2005, e-HResources.com)

Individual competency mapping is a process through which one assesses and determines one's strengths as an individual worker and in some cases as part of an organization (WiseGEEK). It concerns two areas: emotional intelligence, and the strengths of the individual in areas like team structure, leadership and decision-making. They may also use competency mapping to analyze the combination of strengths in different workers to produce the most effective teams and the highest quality work.

Competency mapping is implemented during the process of recruitment of new employees in order to emphasize specific skills, required for a particular job position. The disadvantage of such an approach may be an incomplete evaluation of all the needs and/or capabilities required, or in the fact that some people tend to overestimate their own abilities. Competency mapping also requires much time and one may be reluctant to do all the work, which is required to map all competencies. Nevertheless, competency maps are important for the future development of the structures of a firm or for personal development of individual skills.

McClelland (1973) was also the first to develop a methodology of competency modelling. A competency model (LeBleu, Sobkowiak, 1995) comprises three core elements for successful performance in any job position. These elements are:

- Knowledge – understanding of technologies;
- Technical and non-technical skills: effective project management, writing and speaking skills; and
- Appropriate on-the-job behaviour patterns: communication skills, capacity of finding and using necessary information etc.

Competency modelling is different from knowledge modelling. Knowledge modelling means knowledge life

Fig. 1. Competency map of individual development (from Hollmann, Elliott, 2006)
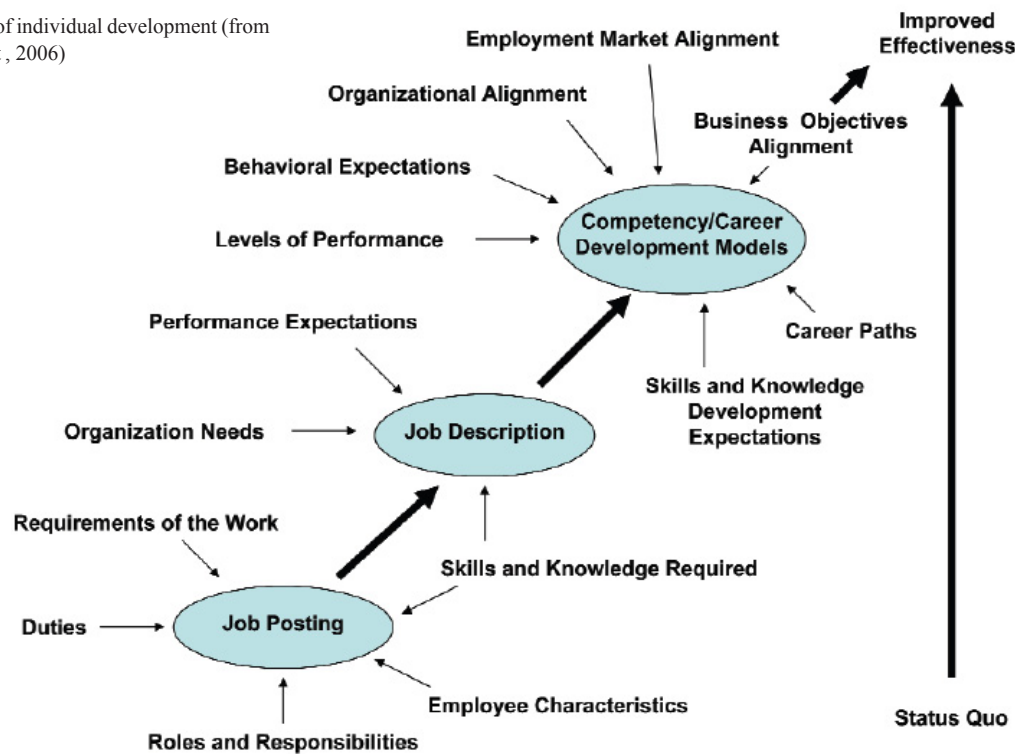
cycle modelling (Nonaka, Takeuchi, 1995) or knowledge contents and structure modelling (Houška, Beránková, 2006, 2007).

Organizations can model the competencies that will predict success in their operating environments by studying what current top performers do, more often and more effectively, for better business results. Most often the competencies that separate truly outstanding performers from merely adequate ones consist of behaviour patterns based on aptitudes, knowledge, traits, and motivations (Goldstein, 1995). A competency model (Harzallah, Vernadat, 2002) should describe:
• Competencies required by a system,
• Competencies acquired by individuals,
• Competency resources structured into categories and subcategories,
• Competencies defined in context,
• Competencies necessary for achieving a specific goal.

Although this definition supposes descriptivism of the competency model, we believe that there is a necessity to distinguish between prescriptive, descriptive and normative models. Lepsinger and Lucia (1999) suggest that for best performance the competency model should not only identify the necessary skills and knowledge (descriptive model, competency map), but also define the expected outcomes of their performance (normative model). These outcomes are related to business objectives and strategies. The process of competency modelling, which shows the necessary competency, is a prescriptive model (Gray, 1999).

Dalton (1997) points out that a competency model has to be constructed for the future, not for the present, because it is impossible to use when conditions change. Implementation and validation of competency models is necessary for its proper application. Unvalidated competency model will neither adequately describe persons with appropriate attributes, nor will it be effective in meeting business goals.

Mathematical competency modelling, System Theory and Operations Research/Management Science (OR/MS) modelling processes represent the scientific approach toward the complex organisational decision problems, such as the problem of best competency structure. From this point of view a competency model must be a normative model. Improving existing competency models and good designs for new competency models are the goals of this approach.

Hollmann and Elliott (2006) propose a competency map (rather then a model), which describes how an individual can move beyond his or her current job posting (Fig. 1).

Mirabile (1997) introduces a descriptive competency model (Fig. 2). Three ways of rating an employee's level of competence are used in this model:
• Absolute rating scale – discrete rating with a description for each level,
• Forced-distribution rating scales – absolute rating with limits, and
• Paired-comparison rating based on pairwise comparison.

COMPETENCY SYSTEM DESIGN

System Improvement and System Design represent a systematic and complex approach to problem solving. We applied this process in managerial competency modelling with a special focus on competency mapping and modelling. For this demonstration we analyse the whole process of competency system design (Fig. 3).

A COMPETENCY MODEL FOR A SYSTEM ENGINEER	
Technical cluster	**Proficiency ratings**
System architecture Ability to design complex software applications, establish protocols, and create prototypes	**0** – Is not able to perform basic task **1** – Understands basic principles, can perform tasks with assistance or direction **2** - Performs routine tasks with reliable results, works with minimal supervision **3** – Performs complex and multiple tasks, can coach or teach others **4** – Considered an expert in this task, can describe, teach, and lead others
Data Migration Ability to establish the necessary platform requirements to efficiently and completely coordinate data transfer	**0** – Is not able to perform basic task **1** – Understands basic principles, can perform tasks with assistance or direction **2** - Performs routine tasks with reliable results, works with minimal supervision **3** – Performs complex and multiple tasks, can coach or teach others **4** – Considered an expert in this task, can describe, teach, and lead others
Documentation Ability to prepare comprehensive and complete documentation including specifications, flow diagrams, process control, and budgets	**0** – Is not able to perform basic task **1** – Understands basic principles, can perform tasks with assistance or direction **2** - Performs routine tasks with reliable results, works with minimal supervision **3** – Performs complex and multiple tasks, can coach or teach others **4** – Considered an expert in this task, can describe, teach, and lead others

Fig. 2. Descriptive competency model with rating (from M i r a b i l e , 1997)
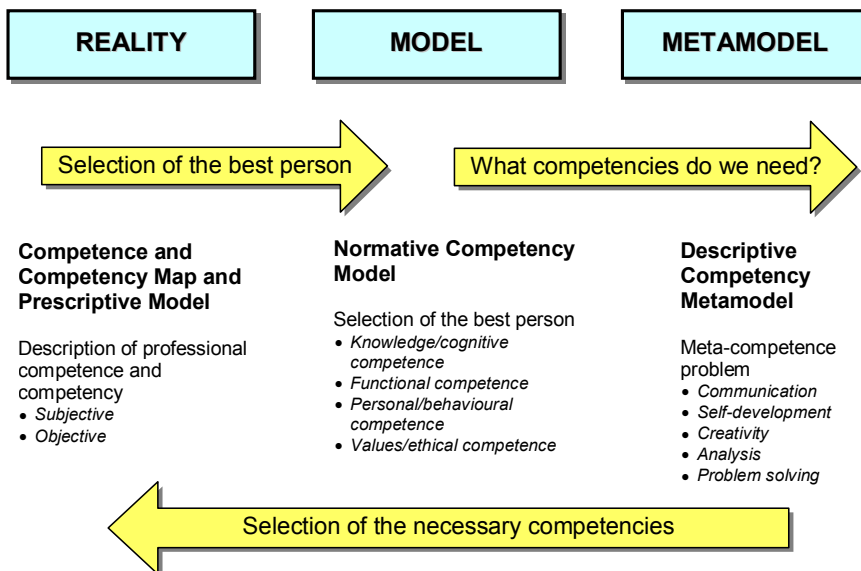

Fig. 3. Competency System Design and metamodelling process

Reality analysis

The first step of the System Improvement and System Design approach consists of analysis and description of **reality**. In this step a person analyses his/her education, skills, knowledge and other characteristics, which are important for his/her future professional development (Fig. 4). A human resources manager provides a similar analysis, which result is a list of necessary competencies for a specific job position.

The result of both these analysis can be represented in a table and/or a graphical form – competency map, and model form – descriptive model. Both forms are based on well-arranged lists of personal characteristics.

The descriptive model of necessary competencies provides guidelines or frameworks to organize a selection procedure or a job interview.

Modelling

Building and using a suitable model for the selection procedure (i.e. when a company wants to recruit a new person for specific post) is in the centre of this second step. Such a model will serve as a tool for selection of the best person, thus it should be a normative model.

A normative competency model may be based on multiple criteria decision-making, because we need to consider a large number of complex factors. Within the framework of System Improvement and quantitative approach in competency modelling we use the Analytic Network Process (ANP) methodology (S a a t y , 2001, 2003). We construct a so-called **ANP Best Candidate Model** (B r o ž o v á et al., 2007).

This model (Fig. 5) is appropriate for tactic decisions and management, with the objective of increasing the pro-
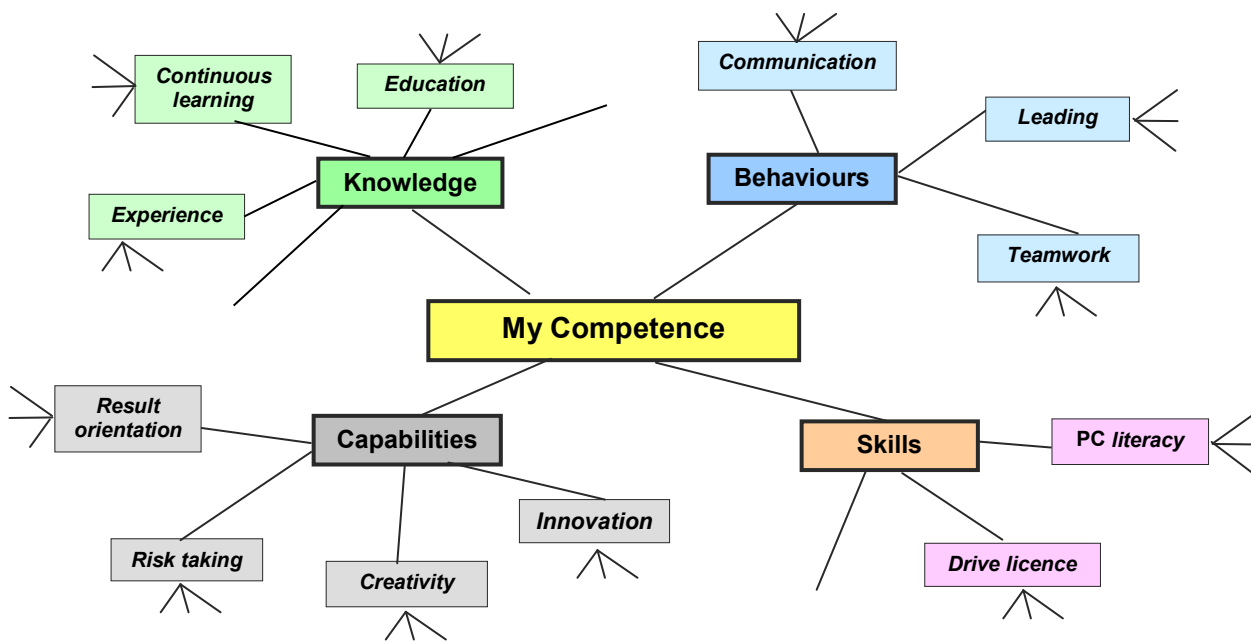
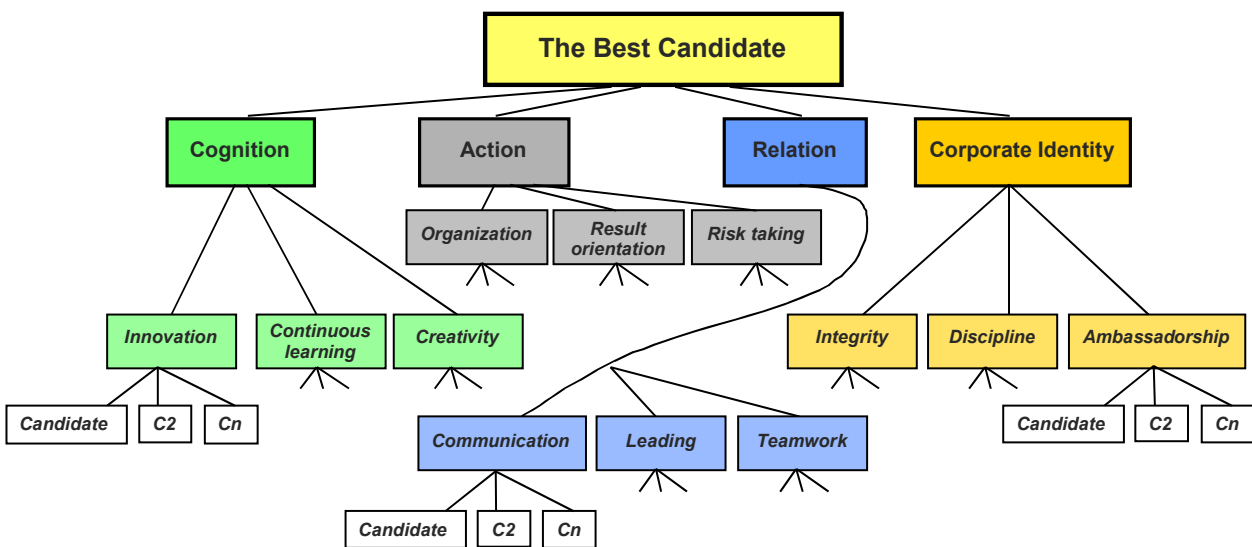Fig. 4. Personal competence map

Fig. 5. ANP Best Candidate Model in the form of ANP tree

ductivity of the system. The main purpose of this model is to find the most suitable person, whose individual competencies fulfil a predefined role.

Metamodelling

When failures occur and the System Improvement process fails, the third step – System Design and metamodelling – must follow. If the ANP Best Candidate Model fails (despite the fact that the selected person may fulfil all requirements) and the goal, which was set, cannot be achieved, then the metamodelling process, which redefines the competency profile, should be implemented. For this purpose the so-called

ANP Best Competence Profile Metamodel has been designed (B r o ž o v á et al., 2007).

This model (Fig. 6) helps human resources managers in designing a new individual competency profile and a subsequent competency model, which is consistent with the job requirements, thus this metamodel should be a prescriptive model.

DISCUSSION

In this article we have applied the System Design process, competency mapping, modelling and metamodelling
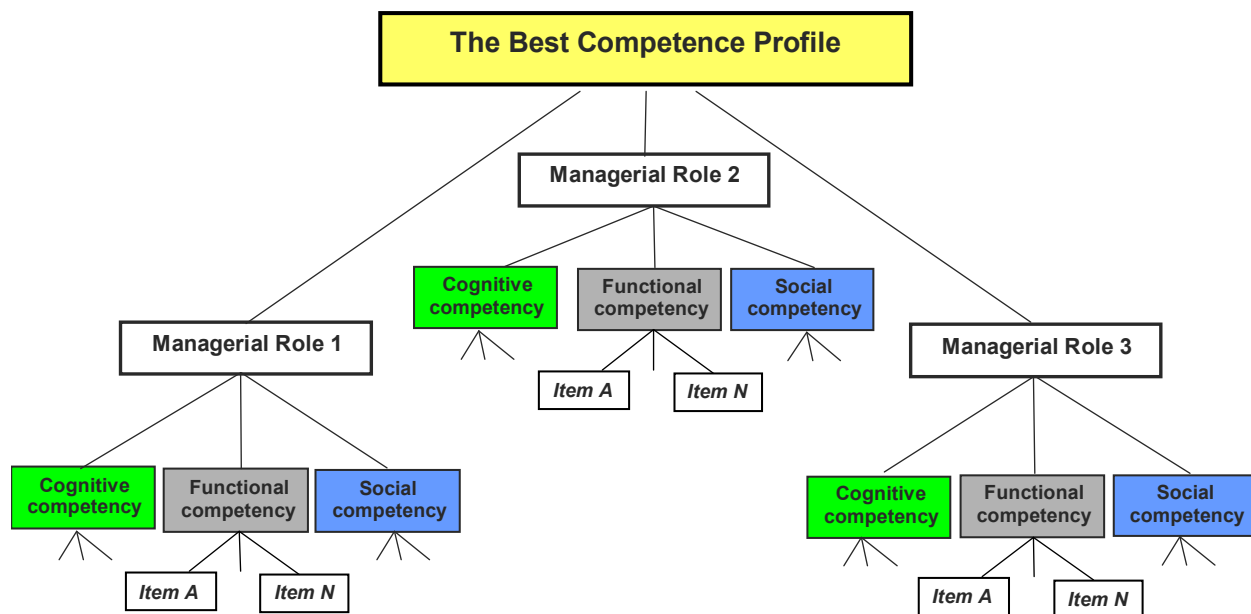
Fig. 6. ANP Best Competence Profile Metamodel in the form of an ANP tree

for selection of the best person or for the creation of the best job competency profile. In accord with the System Design process we therefore recommend the usage of individual competence maps and two competency models. Using competence/y maps as well as both above described types of models may be quite helpful for human resources managers (HRM).

- Reality description – the competence/y map

A competence map may serve as a guideline for individuals in search of a new job. From the HRM point of view a competency map is a tool, which defines the job demands. These maps are descriptive models.

- Reality modelling – the ANP Best Candidate Model

The Best Candidate Model is suitable for recruiting a new team member – a person having the best possible individual competencies. This model is a normative model.

- Metamodelling – the ANP Best Competency Profile Metamodel

The ANP Best Competency Profile Metamodel can help in defining the most important competencies for a specific job. If the initial ANP Best Candidate Model fails, a metamodel may help managers in designing a new competency model, which will be consistent with the new job requirements. This model is a prescriptive model.

REFERENCES

BASSELLIER, G. – BENBASAT, I.: Business Competence of Information Technology Professionals: Conceptual Development and Influence on It-Business Partnerships. MIS Quarterly, *28*, 2004 (4): 673–694.

BROŽOVÁ, H. – ŠUBRT, T. – VORLÍČKOVÁ, L.: System Approach to Knowledge Creation, Sharing and Utilization in Managerial Competency Models. In: Proc. Knowledge Management in Asia and Pacific, Hong Kong, 2006.

DALTON, M.: Are Competency Model a Waste? Training & Development, October 1997.

DELAMARE LE DEIST, F. – WINTERTONE, J.: What Is Competence? Human Resource Development International, *8*, 2005 (1): 27–46.

GARRETT, S.: Competency Mapping: What Is It and How It Can Be Done by Individuals. Carrer Planing and Adult Development Journal, *18*, 2003, Part 4: 43–59. Available at: http://www.careertrainer.com/Request.jsp?lView=ViewArticle&Article=OID%3A112409. Accessed 22 October 2007.

GIGCH, J. P.: System Design Modelling and Metamodelling. New York and London, Plenum Press 1991.

GLIDDON, D. G.: Forecasting a Competency Model for Innovation Leaders Using a Modified Delphi Technique. [Thesis.] Pennsylvania State University, 2006.

GRAY, L.: New Zealand HRD practitioner competencies: application of the ASTD competency model. Int. J. Human Resource Management, *10*, 1999 (6): 1046–1059.

GOLDSTEIN, E. R.: Competency models help identify promising candidates. Healthcare Financial Management, *49*, 1995 (5): 76–77.

HAMEL, G. – PRAHALAD, C. K.: The Core Competence of the Corporation. Harvard Business Rev., *68*, 1990 (3): 79–91.

HARZALLAH, M. – VERNADAT, F.: IT-based competency modelling and management: From theory to practice in enterprise engineering and operations. Computers in Industry, *48*, 2002: 157–179.

HOLLMANN, J. K. – ELLIOTT, B. G.: Core Competencies, Expectations and Career Path for an Estimating Professional. AACE International Transactions, DEV.01, 2006.

HOUŠKA, M. – BERÁNKOVÁ, M.: Mathematical models for elementary knowledge representation. Scientia Agric. Bohem., *37*, Special Issue, 2006: 32–37.

HOUŠKA, M. – BERÁNKOVÁ, M.: Elementary knowledge representation by linear programming model. J. Knowl. System Sci., *3*, 2007 (3).

LeBLEU, R. – SOBKOWIAK, R.: New workforce competency models. Information Systems Management, *12*, 1995 (3): 7–13.

LEPSINGER, R. – LUCIA, A. D.: The Art and Science of Competency Models: Pinpointing Critical Success Factors in Organizations. San Francisco, Jossey-Bass/Pfieffer 1999.

LINTON, J. D. – JAYARAMAN, V.: A framework for identifying differences and similarities in the managerial competencies associated with different modes of product life extension. Int. J. Prod. Res., *43*, 2005 (9): 1807–1829.

MASCARENHAS, B. – BAVEJA, A. – JAMIL, M.: Dynamics of Core Competencies in Leading Multinational Companies. California Management Rev., *40*, 1998 (4): 117–132.

McCLELLAND. D. C.: Testing for competence rather than for intelligence. American Psychologist, *28*, 1973 (1).

McLAGAN, P.: Competencies: The next generation. Training & Development, *51*, 1997: 40–47.

MIRABILE, R. J.: Everything You Wanted to Know about Competency Modelling, Training & Development, 1997.

NONAKA, I. – TAKEUCHI, H.: The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation. Oxford University Press 1995.

PAGEY, U. – D'SILVA, L.: Competency mapping, Express computer, 31. 1. 2005. Available at: http://www.expresscomputeronline.com/20050131/technologylife01.shtml. Accessed 22 October 2007.

ROTHWELL, W. J. – LINDHOLM, J. E.: Competency identification, modelling and assessment in the USA. Int. J. Training Develop., *3*, 1999 (2).

ROWE, Ch.: Clarifying the use of competence and competency models in recruitment, assessment and staff development. Industrial and Commercial Training, *27*, 1995 (11): 12–17.

SAATY, T. L.: Decision Making with Dependence and Feedback: The Analytic Network Process. The Analytic Hierarchy Process Series, Pittsburgh, IX, RWS Publications, 2001.

SAATY, T. L.: The Analytic Hierarchy Process (AHP) for Decision Making and the Analytic Network Process (ANP) for Decision Making with Dependence and Feedback. Creative Decisions Foundation, 2003.

SMITH, M. K.: Competence and competency. Infed, 1996. Last update: 06 August 2007. Available at: http://www.infed.org/biblio/b-comp.htm. Accessed 22 October 2007.

WiseGEEK: What is Competency Mapping? Available at: http://www.wisegeek.com/what-is-competency-mapping.htm. Accessed 22 October 2007.

WHITE, R.: Motivation reconsidered: the concept of competence. Psychological Rev., *66*, 1959 (5): 279–333.

e-HResources.com: Sample Question – Competency Mapping, 2000. Available at: http://www.e-hresources.com/Samples/sample1.html. Accessed 22 October 2007.

BROŽOVÁ, H. – ŠUBRT, T. (Česká zemědělská univerzita, Fakulta provozně ekonomická, katedra operační a systémové analýzy, Praha, Česká republika):

Mapování a modelování kompetencí v procesu System Design.

Pojem kompetence byl poprvé použit v roce 1959 pro popis osobních charakteristik ve vztahu k pracovnímu výkonu a motivaci. Moderní chápání tohoto pojmu rozlišuje tři pojmy:
- individuální kompetence,
- pracovní kompetence,
- klíčové kompetence firmy.

Kompetence představují soubor faktorů a charakteristik nezbytných pro plnění určité pracovní pozice jednotlivcem či pro zajištění konkurenční výhody firmy v tržním prostředí. Při hledání pracovního uplatnění by každý měl začít mapováním svých individuálních kompetencí, které může nabízet. Z hlediska firmy musí analýza a hodnocení kompetencí začít mapováním kompetencí nezbytných pro určitou pracovní pozici. Kompetenční modely pak slouží k porovnání požadavků firmy a kompetencí uchazečů o pracovní pozici a k výběru zaměstnanců.

Problémy v oblasti řízení kompetencí, v personalistice, při výběru vhodných zaměstnanců jsou s rozvojem znalostí a možností lidí i firem stále složitější. Jejich řešení vyžaduje systémový přístup a využití obou procesů „Zdokonalování systémů" (System Improvement) i „Navrhování systémů" (System Design) a metamodelování. V tomto článku analyzujeme tento přístup k řešení kompetenčních problémů s využitím různých typů kompetenčních map a kompetenčních modelů.

individuální kompetence; pracovní kompetence; mapování kompetencí; modelování kompetencí

Contact Address:

RNDr. Helena B r o ž o v á , CSc., Česká zemědělská univerzita v Praze, Fakulta provozně ekonomická, katedra operační a systémové analýzy, Kamýcká 129, 165 21 Praha 6-Suchdol, Česká republika, tel.: +420 224 382 380, fax: +420 224 382 354, e-mail: brozova@pef.czu.cz

---