# Preliminaries for Dynamic Competence Management System building

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*Abstract*—Competence management systems are an important addition to knowledge management systems. Competencies can be processed, during the identification, assessment and acquisition processes, because there is a certain set of tools used to test competencies and estimate their levels. In this paper, we focused on the analysis of the concept of Dynamic Competence Management System. The system takes into account competence changes caused by the efflux of time and competence diffusion process in project group.

## I. INTRODUCTION

THE management and control of knowledge and skills, and more recently the management of firms' competencies have turned out to be essential factors of industrial processes' performance and part of a strategic objective of human capital management [2]. In studies related to knowledge management, managing competencies is becoming a crucial research problem [22]. On one, hand it is being analysed from the point of view of an educational organisation in which we focus on transparent description of a student's achievements in a form of their competencies and their levels described [15]. On the other hand, we analyse competencies in companies. According to [26] *intellectual capital=competence x commitment*. Competence profile of an employee should allow us to make the right decisions regarding training, assigning to a project or even recruiting. Moreover, the knowledge about the competencies is produced and transformed by identification, assessment and acquisition processes [25]. Competencies can be processed because there is a certain set of tools used to test competencies and estimate their levels (e.g. http://www.inspeo.com, http://www.matchinglab.com, http://www.actonomy.com/) and methodology to competence assessment [14]. Moreover, the process of competence computing should be understood as enabling the use of competence databases for inference and combination of competencies for different functions and processes, not as a reductionist account of competencies to numeric models [6].

Large enterprises are characteristic of several features that cause difficulties in managing competencies of their employees. The first feature is a high personnel rotation on different positions. Second one is related to the lack of standardised system approach regarding saving and storing information about competencies. The competencies themselves change in a dynamic way, employees thanks to trainings or being members of some projects are developing and/or achieving new competencies. Additionally, we have to factor in a constant obsolescence of knowledge, which affects the competencies achieved by certain employee. Luckily this process is being avoided by implementing Life Long Learning policy. Organisations constantly approach the question of what employees are needed for certain projects, so that its rate success will be as high as possible thanks to certain set of competencies.

This paper will describe the concept of Dynamic Competencies Management System (DCMS) which will help in better processing of the dynamic nature of competencies. There are several reasons to create and maintain the DCMS in the organization [4]: (1) they can provide identification of the skills, knowledge, behaviours and capabilities, needed to meet current and future personnel selection needs, (2) they can focus the individual and group development plans to eliminate the gap between the competencies requested by a project, job role, or enterprise strategy and those available. The existing systems to not support dynamic aspects of competence management enough. Systems focused on providing the tools for recording competence profiles and use them to select the employees to the project.

The first part will include an overview of literature related with competencies management in a typical organisation. Next, the components and functions of the DCMS will be defined. After that we will clear up the concepts related to the DCMS and its relation. The next part will showcase dif-

ferent approaches regarding modelling the dynamic nature of competencies. At the end, the social network approach to dynamic nature of competencies modelling will be discussed.

## II. COMPETENCE IN THE ORGANIZATION

According to [10] the competence is a observable or measurable ability of an actor to perform a necessary action(s) in given a context(s) to achieve a specific outcome(s). The competence information (competence profile) is a data about a competence that may be aggregated for communication among individuals, organizations, and public administrations. The more detail discussion about competence notion can be found in [5] or [16]. The history and background of standardization in this area and research project are covered in [7].

Generally speaking the competencies in the organization are placed on unit (organizational), collective (team) or individual level [17]. The typical related competencies are presented on Tabele I.

TABLE I. TYPICAL COMPETENCIES IN ORGANISATION (BASED ON [13])

| Unit Competence | Collective Competence | Individual Competence |
|---|---|---|
| - Knowledge Landscape<br>- Knowledge Assets<br>- Information Sharing<br>- Push/Pull Power Balance<br>- Synergy Creation | - Knowledge Sharing<br>- Cultural Integration<br>- Resources Utilization<br>- Innovation<br>- Management/ Leadership | - Result Orientation<br>- Role Commitment<br>- Continuous Learning<br>- Networking<br>- Creativity |

Based on the [8] we can defined what qualities and capabilities the competent person or team require:

1. The domain knowledge empirical, scientific or a blend of both;

2. The experience of application (knowing what works) in different contexts;

3. The drive and motivation to achieve the goals and strive for betterment/excellence;

4. The ability to adapt to changing circumstances and demands by creating new know-how;

5. The ability to perform the requisite tasks efficiently and minimise wastage of physical and virtual resources;

6. The ability to sense what is desired and consistently deliver that at a high quality to the satisfaction of the end client.

While creating a IT system that will allow for competencies processing we must take into account the nature of competencies. The main medium for competencies caring is human, its work and personal development affects the parameters of given competence. Competencies are considered as an union of different components. Thanks to literature analysis (e.g. [7], [20], [21]) we can distinguish some components like: knowledge, skills, experience, etc. The important issue is the question of whether competence is a binary quality or not. According to [7] in natural language, and in other

domains such as law and biology, competence is seen as binary, someone is either competent or not. In the educational domain, however, the competence can be graded on a scale, and that it can have degrees or "dimensions".

Competence can get gradually stronger, in a situation where surroundings affect and stimulate its components. For example, we acquire new skills in a training session or while working (e.g. software developers programming everyday). Competence (its level) can also degrade. The most common reason for it is not using the given competence in everyday work. The other is thanks to technology progress which makes the components of competence outdated. We can distinguish different relations between competencies which affect the interaction between them. Increasing competence in a certain competence group (e.g. communication) can affect the increase of other competencies (e.g. sales of products). Next issues regarding competence processing in an organisation start to show up when we take a look from a company's perspective. From the company's point of view, certain competencies are created only by combining the competencies of a greater number of employees. The complexity of these combined competencies is too great for a single person to obtain this kind of competence.

## III. DYNAMIC COMPETENCIES MANAGEMENT SYSTEM DEFINITION

Based on literature analysis we can specify the following functions of the Dynamic Competence Management System (DCMS): employment planning, recruitment, trainings, raising work efficiency, personal development, managing key competencies. The literature current thinking is that competence management can be organized according to four kinds of mutual related processes [1]: competence identification, competence assessment, competence acquisition, competence knowledge usage.

Currently in Competence Management Systems, the analysis of changes happening in competencies by time is much confined. Employee, while working in a project group, develops his/her soft competencies and acquires experience and knowledge that later result in hard competencies. At the same time, some competencies (when not used) can decline. This process leads to a rapid obsolescence of employee's competencies profile. From the point of view of organisation, the process of managing competencies is dynamic because indicators comprising certain competencies constantly change thanks to employee's and its surroundings actions in the organisation. Building the DCMS is a complex process. The problem lies in a complex nature of competencies. Just like knowledge, competencies are created in human mind and are manifested by doing intellectual or manual operations correctly.

The core components of typical DCMS are [4]: competence model management, departments management, job roles management, learning object management, employees management, projects management. This functions allow to the competence knowledge model manipulation for insert-

ing, updating and deleting ontology data – knowledge model mapping on competence. The system also support functions for creating, updating and deleting a relationship between two competencies, a job assignment and an association between a learning materials and a competence [4].

Typical tasks of module of competencies processing system include (based on [4]):

- Finding competencies gaps between the existing and the desirable employee's competencies according to the position that he/she occupies, the related function is skill gap analysis for a future position (succession planning),
- Aggregation of individual competencies to the group's level - it is allows to estimated the average organization's/department's/team's proficiency level. This function calculates the average level of proficiency possessed by the employees for all competencies in the competence model for a specific department.
- Estimating the costs of acquiring competencies - it gives employee possessed proficiency level and the corresponding cots (e.g. time duration) for every competence since he/she was hired. The function 'optimizing the process of competencies transfer' is looking for minimal cost. In some cases we need to invest in employee by using function find learning materials for employee/project.
- Building projects groups - is a function that finds an employee who is an expert for a given competence on required level related to the project requirements (find best fit employees for project' function). If there is still no employee, then the system searches for an expert for other competencies (and comparing employees abilities), which are related somehow to base competence.

Practical problems to solve:

1. Discussion and analysis of competencies nature to determine the methods of analysing and estimating them for a certain employee.

2. Proposal methods for manipulating the structures of competencies.

3. Proposal methods for building the competencies profile for given employee.

Corresponding research problems:

1. Mathematical methods of processing and describing competencies.

2. Describing knowledge with a model (e.g. OWL ontology) regarding the acquisition of competencies.

3. Modelling the environment of competencies acquisition (social networks, viruses, network game theory).

4. Modelling and optimising network models of competencies.

## IV. SYSTEM NOMENCLATURE

To define the Dynamic Competencies Management System (DCMS) we need to establish axioms related to building the system:

### A. Organisation

Has a global objective which is maintaining a position on the market. It is possible only by developing owned core competencies. Core competencies are competencies which are unique for the company and help to build a competitive advantage. Currently, in a dynamically changing environment, competitive advantage is not only decided by the fact of owning this kind of competencies but also their high levels. In a knowledge-based economy, employees (and their competencies) and intangible resources of the organisation (e.g. patents) are the main elements of its assets. The key to correct operation of organisation is to effectively manage the process of transferring knowledge which will use its assets in the most effective way.

### B. HR Department

A department in organisation responsible for competencies audit and management. The work of HR department is based on using dynamic competencies management system.

### C. Knowledge worker

Knowledge worker thanks to intelligent operations takes part in project's tasks assigned to him/her. Knowledge worker enhances his/her competencies by taking part in projects and cooperating with other employees (which are willing to share knowledge and they have higher competencies), attending training and self-study. Knowledge worker is described by competence profile which includes: possessed knowledge, competencies and their levels. Moreover, every knowledge worker is also described by his/her individual objectives, cognitive and social characteristics.

Worker has different roles assigned in different projects. Assigning a role requires to possess a certain set of competencies (set of competencies) on a certain level. By assigning a certain position to a worker his minimal competencies are being described.

### D. Project

Conducted by knowledge workers. Each worker has a role in the project. Project is being created to solve a certain task, which is composed from sub-tasks. The condition for conducting a task (sub-task) is to have the required competencies on a certain level. Project always involves working in a group with other knowledge workers.

### E. Competencies bank

It is distinguishing for every company. It contains a set of all competencies in an organisation (both possessed competencies and those planned to obtain). All competencies are related to each other and they form up a competencies network in a company. Each competence has a certain accumulated level for an organisation. The strategic purpose of organisation's operation is to achieve a desired level for each competence placed in competencies network. Every competency is described by description, and related descriptors (see Table II.)

TABLE II. EXAMPLE OF EVALUATION MATRIX FOR
*COMMUNICATIVENESS* COMPETENCE (BASED ON INSPEO.COM
SYSTEM)

| Competence name | Communicativeness |
|---|---|
| **Definition** | Transfer to other information in a clear and understandable way, as well as listening and clarification to what others are saying to us. |
| **Descriptors** (1-5 Likert scale): | A. He/she speaks in an understandable way<br>A.1: He/she is expressed in a vague and difficult to understand.<br>No form of communication adapted to the situation and audience whatsoever.<br>A.2: Sometimes he/she has problems with the formulation of clear and concise expression, even in standard situations.<br>A.3: He/she speaks in a clear, concise, and keeps the topic of conversation.<br>A.4: Even in the case of complex issues and in new or challenging situations (time pressure, challenging the audience), is expressed clearly and precisely. Adjusts the way of expression to the situation and audience.<br>A.5: He/she is expressed in a understood manner, even on specialized topics.<br>Communicate to the other their knowledge on how to communicate effectively. Creates and implements the rules of good communication practices.<br>B. He/she ensures that the message was understood by the public<br>…<br>C. Encourages others to share their opinions<br>…<br>D He listens to speeches of his callers / listeners<br>…<br>E Knows the rules of proper written communication<br>…<br>F. It strengthens and validates their content through body language (posture, gestures, facial expressions, distance)<br>… |

### F. Competencies network

A graph structure showing relations between competencies. Adding new competence to the network requires to make a relation with a competence already existing in the network. Usually it may involve creating new competencies to maintain/create relations with competencies that are already in existence. All competencies in the network must be connected.

### G. Competencies catalogue

Description of positions, including competencies and their minimum level required to work on certain positions.

### H. Competencies audit

A process that focuses on establishing what competencies and on what level, from the competencies bank, a certain employee possesses. Competencies audit is conducted by completing different psychometric tests, chats with a qualified assessor or an outside certificate that can confirm competencies.

### I. Process of acquiring competencies

Process of acquiring competencies consists of different kinds and types of knowledge (ability) transfer to achieve a certain knowledge/experience for an employee and thus al-

lows for achieving good results and reactions regarding certain competence. The transfer occurs between employees or between employees and dedicated systems.

### J. Knowledge status

Set of certain areas of knowledge, measured with special equipment, that are included in the certain competence.

### K. Core competencies

A set of competencies which are essential for an organisation to work.

### L. Organisation graph

Shows relations between workers that occur in certain organisation. It changes over time.

Typical organization is composed of many different departments. In the context of competency management HR department is the most important, because it is responsible for storing information about the competences of employees in the competencies bank in form of the competence profiles. It also performs regular audits of competence, which provides the information necessary to update the employee's competency profile. Audit examines different areas of competence of the employee's knowledge and determine their constitution (knowledge status). All profiles are stored in the bank's responsibility. The structure of competence bank is a graph structure mapping network of competencies. HR department also manages a catalogue of competencies, which is used when hiring new employees.

When the project is coming up the HR helps is project stuff based on an analysis of the project required competencies and the competencies already possessed by the individual employees. When deciding on the allocation of staff to the project , the one must also take into account the organizational structure of the company, expressed as a organisation graph.

In addition, the HR department supports and manages the process of competencies acquiring. In this process, the key issue is to ensure an adequate level of the core competencies in the organization and the desire to cover the competence of the entire competencies network.

### V. Discussion of the Dynamic Competencies Model

In previous sections of the article it was discussed that the competence of a person changes and is subjected to many factors. Thus, the competence should be considered as a dynamic system that depends on many factors, mainly related to time. The competence of a person can be acquired in the process of training or strengthen during work which requires using this competence. Moreover, the competence can be transferred from others while working collaboratively. The competence of a person can also decline while he or she is not actively using it for certain period of time. The pace in which the competence is acquired, strengthen, transferred or declining usually is non-linear and dependent on many fac-

tors, like the nature of competence, its structure, context, current state and individual qualities of a person.

Like any dynamic system the competence can be represented by the set of its states variables values. State variables represent different pieces of a person's competence, like pieces of knowledge, information and skills, thus the competence can be seen as the function of several time-based arguments, such as:

- Time of training (acquiring).
- Time of working actively using competence (strengthening).
- Time of inactivity (decline).
- Time of team work/problem solving (transfer).

The proposed model should reflecting the structure of the competence and represent it as a set containing skills and knowledge existing in a certain domain. The model should be aware of context of competence and be able to reflect relations existing between them (ex. composition, similarity, etc.). There are many researches on this subject that propose well elaborated models [3], [29]. These approaches usually focus on providing exact models of different professional domains for human resource description or training planning. The intention of this model is to extend regular competence model by adding fuzzy measures describing the level at which a person mastered certain competence. The description of personal competence will use fuzzy representation of set to precisely show the "strength" of every element of competence by setting quantitative value of degree of membership for every element of the competency set. This approach will allow performing quantitative analysis on personal competences (ex. level of meeting competence requirements by a person, comparison of competence of two people for staffing purposes etc.). There are several works representing this "fuzzy" approach to competence modelling (e.g. [17] ,[27]) but, in turn, they lack the possibility to map complex relationships between competences.

The next step of the work is to elaborate the method for evaluation of the level of competence basing on analysis of a person portfolio (analysis of training history and professional experience in order to assess the value of the level of competence). This analysis will take into account the phenomenon of "learning curves", which assumes non-linear pace of knowledge and skill increase during work and learning process. On the last stage the model for group competence will be elaborated. The model will allow representing competence of the whole organization consisting of many individual professionals. This method will cover topics such as: aggregation of the level of competence, complementarity, competence domain coverage etc.

The competence model assumes fuzzy representation of set to precisely show the "strength" of every element of competence by setting quantitative value of degree of membership for every element of the competency set [17] ,[27].

The model will focus on modelling the process of competence development, which occurs during training and professional work. In the case of the fuzzy competence set this process reflects in rising the degree of membership for the element representing the competence under development [19].

Known studies on this subject assume linear relationship between the increase in the competence strength and the time spent on training. On the other hand, studies in the domain of cognitive science show that the learning process is non-linear and goes according to different "learning curves". Thus, the main goal of this work will be to develop the formal competence extension model, which will take into account the idea of "learning curves" in order to reflect non-linear relationship between time of training and competence strengthening. The formal model of non-linear competence extension will be then used to develop the method for competence extension cost analysis. This method bases on the assumption that extension of personal competence requires effort that takes some time, which can be translated into financial cost by introducing cost factors.

## VI. SOCIAL NETWORK APPROACH TO DYNAMIC COMPETENCIES MANAGEMENT

Within the organization social networks can be identified, which are related to the flow of information and exchange of knowledge. Studying structures within an organization can be considered in terms of improving the information flow mechanisms and the identification of key members of the organization. Social network analysis methods can be used that make it possible to determine the quantitative parameters of the network, identifying community and relationships within the network structures [28]. This type of research involves both static properties of networks and their evolution over time.

Social networking is also used for measuring competence, which may relate to specific network segments, competence of separate groups and members of the community. While the subject matter of competence is usually considered both static and focused on the analysis of individual units, in this article it relates to the recognition of dynamic problems which can include movement of competence in the organization. That concept includes flow modeling competence within social network using diffusion models derived from the field of epidemiological studies which in recent years have been developed in the direction of social networking and viral marketing [30]. This is used to identify trends related to the prediction the range of diffusion, diffusion models and the identification of network nodes, which should be contacted by an initial infection [9]. The analysis of diffusion processes is based on in epidemiological models, linear model threshold or independent cascades model and branching processes [12].

In the area of competence-oriented modelling, a number of areas can be identified where the diffusion processes take place when acquiring competence. It is therefore a possible

link between the methods of social network analysis to identify key members of the team, whose competence is worth investing. Taking into account the mechanisms of diffusion a flow of competence in an environment can be specified where there is exchange of knowledge among team members and use the multidimensional approach [11]. Competence can be treated as information diffusion processes and can move between team members. The number of contacts between team members is conducive to the flow of competence and invests in workers for whom the identified high communication activity can promote the exchange of information to a greater degree than improving the skills of workers whose social activity is reduced.

The proposed concept of using methods of social network analysis and modelling of adaptation mechanisms of diffusion processes can find a number of applications in the analysis of competences and is reflected in both the theoretical and practical areas related to this topic.

## VII. CONCLUSION

The construction of the system, with implementing the new approach to competence management, requires an in-depth conceptual phase. This article was devoted to this goal. The dynamic aspects of competencies level fluctuating have to be implemented with the proposed models, data structures and system components. The most important observations from the paper are:

- Typical tasks for competencies processing include: finding competencies gaps, aggregation of individual competencies to the group's level, estimating the costs of acquiring competencies, building projects groups
- Competencies bank, catalogue and network are the main elements that store information about competencies of employees in the organization.
- The competence level is changing in time during following situations: training (competence acquiring), active using (competence strengthening), inactivity (competence decline), team work/group problem solving (competence transfer).
- Transfer of competence in the group through the realization of tasks within a project can be analysed using the tools and methods of social network analysis.

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