An Interactive Visualization Model for Competence Management: an Integrative Approach

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Abstract: This research aims at innovative IT support for competence management (CM) integrating organizational, group and individual perspectives. Our method is action case research resulting in a design model. This paper addresses our overall approach towards an integrative CM system, which is usage-oriented. Based on in-depth analysis of seven business companies' CM activities, we present a new interactive visualization model for CM. The model is suitable for explorative analysis and for communicating competence situations at individual, group or organizational levels. It provides support for constructing competence information incrementally. We view competence descriptions as negotiable estimations with varying verification levels, and use a competence representation which deals with uncertainties of estimations. Our view on competence is novel, and has far reaching consequences. Future work includes a running prototype and planned pilot studies.

Keywords: Competence management, competence representation, interactive visualization, graphical user interface, action case research, ontology-generic
Categories: H.5.2, H.5.3, H.4.3

1 Introduction

Competence management (CM) refers to how competence is managed with respect to organizations, groups and individuals [Berio & Harzallah 2005]. The organizational view has shifted from using the term *qualifications* to the broader term *competence* [Boucher et al. 2007]. Much research emphasises the organisational perspective related to strategic planning, involving identification of competence gaps and strategies to fill these gaps [Lindgren et al. 2004]. They found that for organisational CM activities, skill-based competence descriptions are appropriate and often used. For individual CM activities, job-based descriptions are common. There is a tension between these two views: i) skill-based, as personal descriptions with a present and future focus and; ii) job-based, as positional descriptions with a focus on the past. According to [Lindgren et al. 2004], organizational needs and individual interests should be integrated but there are few information systems designed to support CM at both levels. Integrating these perspectives is one of our aims, as is the initiative in [Berio & Harzallah 2007]. Moreover, visualization and flexible reporting of competence information is a key design challenge [Lindgren et al. 2004].

We base our findings on a research collaboration project conducted together with Networking Companies: a network of consultancy firms, service- and knowledge-based organizations, as well as more traditional production companies.

They all have varying approaches to CM and uses different systems for support. Our challenge is to identify and develop IT support for CM beneficial for individual companies as well as for the network as a whole. One initiative is the visualization model presented here. Due to the companies' diversity of needs, IT support and CM processes used, our solution must work as add-on to existing CM systems (CMS) as well as standalone. It must be flexible with respect to the supported competence information as well as general with respect to competence processes. Our approach is in the spirit of [Ahlberg 1996]: a graphical, explorative information environment, in which data can be examined interactively. Our ambition is similar to [Lindgren et al. 2004], regarding the empowerment of individuals.

The goal of this paper is to develop a flexible interactive visualization model to support competence management from the perspective of organizations, groups, and individuals. In doing so, the following research dimensions are addressed:

- The role and purpose of CMS within organizations.
- The roles of IT support in competence management workflows.
- The view of competence representation in CMS.
- Requirements on competence management systems.

Our research approach resembles action case research - a combination of action research and case study resulting in a design model as described in [Yen et al. 2002]. The paper is organised as follows: Related CMS, Empirical Findings, Our Approach, The Visualization Model, Conclusion and Future Work.

2 Related Competence Management Systems

Most CMS systems are used as storage for competence descriptions of employees, and are mainly used by human resource people and management. Individuals may be responsible for data entry and updating information but there are little incentives for doing so. Consequently, information is often inaccurate and incomplete, and therefore less useful in practice [Lindgren et al. 2004]. It is a challenge to create acceptance for competence definitions, and to keep information dynamic and relevant [Lindgren 2002]. According to [Harzallah et al. 2006], existing tools are inflexible and no ontology supports a common understanding of competence.

There are many attempts to describe competence. [Boucher et al. 2007] use the levels *individual competence*, *collective competence* (a group of persons) and *global competence* (organisational ability). In [Harzallah et al. 2006] *competence required* and *competence acquired* is used. Structures are often fixed and not open for changing contexts, they claim. In [Lindgren et al. 2004] a time-dimension is added: not only the past (Competence-in-the-store) and the present (Competence-in-the-use) but also the future (Competence-in-the-making). In [Berio & Harzallah 2005] four main processes for competence management are identified: *competence identification* (identify required competencies), *competence assessment* (assess acquired competence), *competence acquisition* (how required competencies can be acquired) and *competence usage* (how to use the knowledge of acquired and required competence). In this work we focus on *usage*, but competence assessment and identification are involved as well.

2.1 Requirements of Competence Management Systems from Literature

We have found the following requirements and recommendations from CMS literature, regarding integrative aspects, functionality and competence representation: There should be explicit links between company strategies and required competencies [Harzallah et al. 2006; Lindgren et al. 2004] and individual competence interest *and* organizational needs should be integrated. Standardized and sharable representation of competence is needed [Harzallah et al. 2006]. Flexible reporting as well as possibilities of making distinctions between past, present and future competencies is important [Berio & Harzallah 2005; Lindgren et al. 2004]. Regarding functionality, it is important to see competence development over time for acquired, required and desired competence, from the organizational, group and individual perspective respectively [Lindgren 2002]. Thus, status of acquired and required competence should be represented [Harzallah et al. 2006]. Providing features to query (search) the competence information for required competencies is also needed [Lindgren 2002]. Concerning competence representation, formal and informal indicators in competence descriptions should be balanced; the person behind a chart/diagram should be visible and user control is important for keeping competence data up-to-date. Finally, CMSs should provide flexible visualizations of competences and interests [Lindgren 2002].

3 Empirical Findings

The collaboration with Networking Companies is on-going and started one year ago. The network management and 7 member companies are actively involved in the research project. We have conducted in-depth interviews with the companies, held regular half-day meetings and three 2-day workshops. We have conducted a survey to determine interest in a CMS from the individual, group, organisational and network perspectives. Our empirical findings so far are reported in [Lundh Snis et al 2007] and can be summarized as follows: Awareness of CM is high in all companies, but the level of systemization varies. Common ambitions include to work with CM as a continuous process; to have more efficient tools integrated with current activities; to be more strategic and longsighted; to better integrate individual, group and organizational levels of CM; to get “snapshots” of competence status; to have more explicit competence profiles; to get competence profiles accepted; and to make employees engage in competence development. The amount of work required to produce competence information in most CMSs is considered a barrier to IT use. Most companies have competence profiles and descriptions of positions documented in business software or elsewhere, but need support for competence management.

4 Our Approach Towards an Integrative CMS

We take a *user- and usage-oriented approach* to an integrative CMS, with a skilled- and verification based *view on competence representation*. We have designed an *interactive visualization model* which is *ontology-generic* and allows for *incremental construction* of competence information.

4.1 User- and Usage-Oriented Approach

Competence information *usage* is our focus. The key question is: What is the competence information used for? We argue that the main interest for both management and individuals is the future. Organizational interests include preparation for future challenges and utilizing human resources in accordance with individuals' capacities, ambitions and interests. Individuals' interests include personal career options and stay up-to-date with professional development to be attractive in the job market. Strategic management and individual career planning are complementary, and integration constitutes a basis for empowerment of the individual [Lindgren 2002].

4.2 View on Competence Representation

Competence is a complex notion, but must be represented in some way in IT systems. Our position is in accordance with [Höfferer & Hiermann 2003]: competence of an employee can never be fully reproduced in a system. Facts describing the past are unproblematic, but a future focus involves competencies such as abilities, behaviours, transferability of knowledge in new situations etc. Such competencies are subject to *judgement* and can only be estimations, which are difficult to value. Our approach is to accompany estimations with "arguments", i.e. *verification objects*. These objects reflect the basis for estimation, and can include formal qualifications, experiences, claimed talents or abilities. Someone might argue that being the head of a large household contributes to managerial competence, and in [Lindgren et al. 2004] the information that someone lived in Germany for several years was considered important information regarding language competence. Due to the complexity and uncertainty about what constitutes competence, our approach is to include verification objects as motivations of the estimations, and to make these available to the viewer.

Regarding the problem of correctness and completeness of competence information data, we take the opposite approach to [Berio & Harzallah 2005]: we allow imperfect data. Aligned with our view of competence as more or less verified estimations, we provide the user with a *verification level*: the extent of verifications. The purpose of the verification level is two-folded: to reflect the level of uncertainty of the estimation and to stimulate verification of claimed competencies. The degree of accordance with real conditions is crucial for information usefulness.

4.3 Ontology-generic

A flexible extension of competencies must be possible at all times [Höfferer & Hiermann 2003]. We provide a framework where any hierarchical structure (for competence descriptions) based on any scale (for competence estimations) can be defined and altered as appropriate. It is a three-layer system with competence data as the base level, a data organizer as the middle level, and a visualization model as the top level. This way, competence data can be imported from various systems. In the data organizer competence hierarchies are defined, and data (verification objects) are related to their corresponding competencies. Estimations and verification levels are aggregated to the level above. Several structure definitions can be associated with the same basic data. The visualization model graphically presents the data organized in accordance with the chosen structure definition.

4.4 Incremental Construction of Competence Information

To lower the threshold for data entrance (identified as important in our empirical findings and in [Höfferer & Hiermann 2003]), we searched for solutions providing incremental construction of information. Just as structures can emerge over time, our model allows for competence information to be provided incrementally. This is due to the combination of emergent structures, and the notion of verification level. For example, a first estimation of a person's competence can be done immediately by giving quick estimations in a few important categories, without any subcategories or verification objects. Naturally, such estimation has low credibility, due to the lack of detailed information and verifications - but the uncertainty is reflected in the verification level and is visible in the graphical representation.

4.5 Interactive Visualization Model

Information visualization can provide useful tools and techniques for gaining insight and understanding of data [Zuk et al. 2006], and can amplify cognition [Card et al. 1999]. The purpose of our visualization model is to display competence structures and estimated competence levels for individuals, aggregated to group and organizations. It is based on a hierarchical, details-on-demand graphical representation of data. Effective overviews of data are equally important as rich descriptions of specific data elements [Ahlberg 1996]. Only showing details on requested are instrumental for the concept. To enable an explorative support for analysis and decision making at all three levels, a direct manipulation [Schneiderman 1983] model is used. Direct manipulation provides efficient and intuitive interaction methods [Baudel 2006].

5 The Visualization Model

The visualization model is based on a new graphical diagram (see Figure 1), which is a modification of the radar diagram in Excel. The "spider web" is divided into compartments, one per main category. The levels in the compartments represent estimation levels. Each triangle represents a competency where the height represents estimated competence level and the opacity illustrates verification level. Opacity is a natural mapping of uncertainty [Tufte 1990]. Levels are aggregated. A compound competence can be unfolded and folded, to provide details-on-demand (diagram B and C). An atomic competence can display verification objects (diagram D). The colour coding is optional. It differs from radar diagrams by being hierarchical, and to provide the detail-on-demand principle. This representation respects the semantic notion of levels being independent of their surrounding levels, which is not true for radar diagrams. Semantic soundness is an important quality of visualizations.

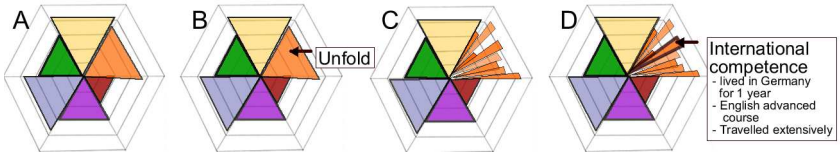

Figure 1. The hierarchical, graphical visualization model

Figure 2 shows an illustration of how the visualization model can support activities such as employee-manager meetings discussing individual progress and competence development plans. Diagram A illustrates the competence status from last year, diagram B the competence goal for this year, and diagram C the difference between the two. Note that with our model, three different dimensions of competence development are present (see diagram C): *competence deepening*, *competence broadening*, and *experience deepening*. Competence deepening refers to increasing the competence level (the enlarged triangle at the bottom), broadening of new emerging competence areas (the new thin triangle in the upper-right category) and experience deepening (new verification objects and the added transparent triangle at the same level). Note that diagram B is the sum of A and C, both semantically and graphically. Diagram D illustrates a comparison of two competence profiles in the same diagram, comparing actual status and planned status in this case.

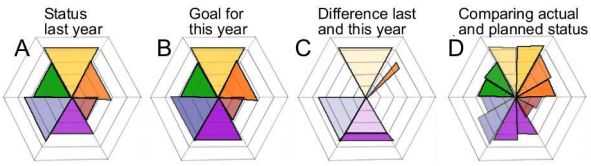

Figure 2. The visualization model when used in CM activities

Figure 3 illustrates different ways of specifying search for matching profiles: where A is an approximate goal profile, B is a requirement specification of certain competencies, and C is criteria for min and max values of competence levels.

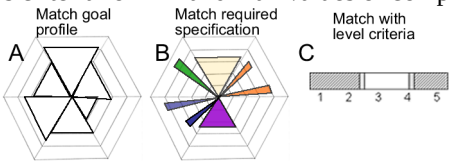

Figure 3. Matching principles

In Figure 4, searching and search results are illustrated, in a different view. In diagram A results are presented as individual profiles. Diagram B shows a comparative view where all results are presented in one large diagram and each category is sorted on competence and verification level, in that order. This can be used for showing aggregated group or organizational competence, or as a result of a search. Diagram C is the same as B with one individual selected, shown by the marked triangles.

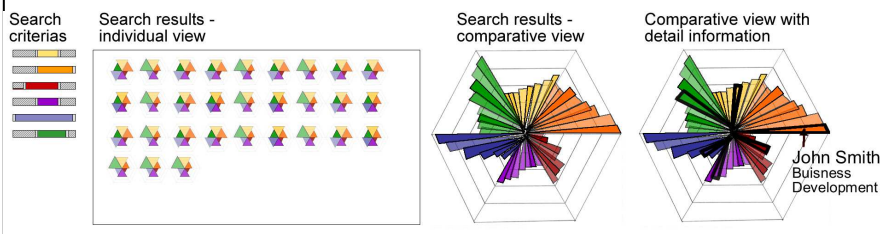

Figure 4. Presentation of search results

The visualization model is general since it can display a wide range of data, and it is constructed from a few basic operations: show a profile, fold- and unfold, show details, add or compute the difference of profiles, compare one or several profiles side by side or in a large diagram, and different ways of specifying a search. Development over time as a sequence of diagrams is achieved by appropriate search criteria.

5.1 Summary of Visualization Model Benefits

The visualization model is a communication tool in the sense that a wide range of competence profiles can be displayed, compared and explored interactively. Different views of the same profile, different profiles or different points in time can be shown and compared, which is valuable as a mean to communicate different competence situations according to [Lindgren et al. 2004]. Acquired, required, planned for and desired competence can all be described with the same type of profile and in the same framework. It allows for a transparent usage: competence profiles of individuals, groups or organizations are all in the same framework. All variations use competence estimation together with verification objects. For planned competence development or interest declarations, verification objects can be used as planned learning activities or motivations of the interest value to the company, respectively. The problem of competence scales being too instrumental is highly reduced by providing verification objects. Employees are empowered since they can be more aware of their role in the organization, more aware of company strategic directions, more in control of opportunities and potential threats in advance. Users may see transparency as an opportunity to market their competence rather than as a threat, allowing for more active development either motivated by their own competence interest or organizational competence needs [Lindgren et al. 2004].

6 Conclusion and Future Work

The purpose of our CMS is to integrate organizational strategic planning, group planning and individual career planning, in the same transparent framework. The role of IT is to provide support for communicating situations and for explorative analyses in current CM activities. Our view on competence as negotiable estimations with varying verification levels is novel and has far reaching consequences. It raises fundamental questions about competence and challenges the current division of power in many enterprises. Future work includes finishing a working prototype and conducting pilot studies with two companies: one which will evaluate incremental construction of competence information from scratch, and the other which will evaluate the visualization model as an add-on to an existing CMS. Both evaluations involve visualization effects, which is challenging and require unusual methods according to [Plaisant 2004].

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