Association for Information Systems
AIS Electronic Library (AISeL)

ECIS 2008 Proceedings

European Conference on Information Systems (ECIS)

2008

Evaluation Criteria to Increase Information Quality in Electronic Knowledge Repositories

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EVALUATION CRITERIA TO INCREASE INFORMATION QUALITY IN ELECTRONIC KNOWLEDGE REPOSITORIES

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Abstract

Knowledge forms an important asset in modern organisations. In order to gain and sustain competitive advantage knowledge has to be managed. One aspect of this is to use Electronic Knowledge Repositories (EKRs) in order to enhance knowledge sharing, reuse and learning. The success of an EKR is dependent on the quality of its content. For knowledge to be stored in an EKR, it has to be captured. One crucial part of the capture process is to evaluate whether the identified knowledge should be incorporated in the EKR or not. Therefore, to increase information quality in an EKR, the evaluation stage of the capture process must be successfully performed. This paper characterizes Critical Success Factors (CSF) for knowledge evaluation and presents six evaluation criteria to guide the evaluation stage in order to increase information quality in EKR:s. In particular we highlight the importance of performing evaluation addressing correctness, relevance, protection and redundancy.

Keywords: Electronic Knowledge Repositories (EKRs), capture, information quality, Critical Success Factors (CSF), evaluation criteria

1 INTRODUCTION

Knowledge Management (KM) is about managing knowledge in such a way that benefits the organization. It can be categorized based on whether it concern knowledge creation or knowledge reuse (Davenport, Jarvenpaa and Beers, 1996), but, in either case, the goal of KM is to support learning. A key form of KM is Electronic Knowledge Repositories (EKRs) (Kankanhalli et al, 2005), which is the focus of this paper. EKRs support learning by enhancing knowledge reuse and knowledge sharing. Knowledge sharing through the use of EKRs must, however, be regarded as a means, not an end, to the purposes for sharing knowledge (Carlsson and Kalling, 2006). To incorporate knowledge sharing in the organizational culture is perhaps the most important factor for successful KM system implementation (O'Donovan et al. 2006) and this is what EKR aims to enhance.

Knowledge sharing through EKR involves people contributing knowledge to the repository as well as people seeking and using knowledge from the repository for reuse (Kankanhalli et al, 2005). In support of the user satisfaction paradigm, Kankanhalli et al (2005) provide evidence that perceived quality of EKRs knowledge directly affects the use of EKRs by knowledge seekers. KM system success requires capturing the right knowledge (Jennex et al, 2007) and the capture of knowledge for an EKR is a critical process. Knowledge capture can be defined as a two stage process comprised of the *identification* of knowledge to be captured, followed by an *evaluation* of the identified knowledge for possible storage in the repository. Storing all identified knowledge causes information overflow and low quality in the EKR resulting in problems to find the required knowledge. "It's difficult to make people remember that they don't need to store everything." as put by an HR manager in a big Swedish company. Hence evaluation is crucial for success. Furthermore, the evaluation stage is also noticed in strategic KM work in Aggestam and Backlund (2007). The quality of the knowledge in the EKR influences knowledge seekers' perceived usage of the EKR (Sharma and Bock, 2005), and therefore it is problematic that poor information quality is a widespread problem. However, there is a lack of systematic support for implementing KM in organizations (see e.g. Wong and Aspinwall, 2004), and the evaluation stage in the capture process as part of KM is no exception. With the purpose to increase information quality in EKRs, *the goal of this paper is to present theoretically and empirically grounded evaluation criteria to guide the process of selecting which knowledge to store in an EKR.* Since Critical Success Factors (CSF) are "…the conditions that need to be met to assure success of the system" (Poon and Wagner, 2001, p.395) the evaluation criteria must meet the CSF for the evaluation stage if successfully guiding what knowledge to select. Thus, to achieve the paper's goal we have carried out a theoretical analysis and a case study in order to identify and characterize Critical Success Factors (CSF) for the evaluation stage and then, based on these CSF, developed the evaluation criteria. Hence, this paper has two contributions:

- a characterization of CSF for the evaluation stage of the capture process
- evaluation criteria for EKRs content

The paper is structured as follows: Our points of departure are described in Section 2 and the research process is presented in Section 3. This section also includes a description of the case. The identified CSF for the evaluation stage and the developed evaluation criteria are included in Section 4. We conclude the paper by some final remarks in Section 5.

2 POINTS OF DEPARTURE

The setting of the paper is Knowledge Management (KM), or more precisely Electronic Knowledge Repositories (EKRs). A literature review is critical for any research project (Webster and Watson, 2002) and based on our literature review, we define relevant concepts and give an overview of KM in this section. Finally, we describe EKRs more carefully.

KM aims to create value for the organization by enabling learning. Even if learning and accumulation of (new) knowledge always start from the perspective of an individual (Jensen 2005), there are different types of KM. One type accumulates knowledge outside people in order to disseminate knowledge to support learning (Wiig 1994); this is the type to which EKRs refers. EKRs enable both individual and organizational learning, and hence support the other two types of KM identified by Wiig (1994): to accumulate knowledge inside people and to embed knowledge in processes, routines etc. With respect to Binney's (2001) six elements, developing EKRs includes both a product and a process perspective. There must be processes associated with the management of the knowledge repository and improvements of work processes in order to support different types of knowledge conversions as described by Nonaka and Takeuchi (1995). The application of technology when building the repository embeds knowledge in the application and the use of it. Binney (2001) terms this transactional KM, which is a side-effect of building knowledge repositories.

There are different types of knowledge. Wiig (1993) terms knowledge that people hold in their minds internal knowledge. Knowledge in e.g. books and IT systems is referred to as external knowledge. From the perspective of an employee, external knowledge is organizational knowledge, i.e. knowledge that remains in the organization even if employees quit. An EKR is a part of the organizational knowledge. Another common distinction in the literature is between tacit and explicit knowledge (see e.g. Gore and Gore 1999, Loermans 1993, Nonaka and Takeuchi 1995, Wiig 1993). Tacit knowledge is difficult to identify and to express since it is highly personal and concerns insights and intuition (Nonaka and Takeuchi 1995, Blodgood and Salisbury 2001). Explicit knowledge is easier to express and can, in contrast to tacit knowledge, also be processed by a computer (Blodgood and Salisbury 2001, Nonaka and Takeuchi 1995). From an organization's perspective organizational knowledge stored in a repository can be regarded as explicit and organizational knowledge stored in the culture and embedded in work routines as tacit. Figure 1 summarizes the discussion so far.

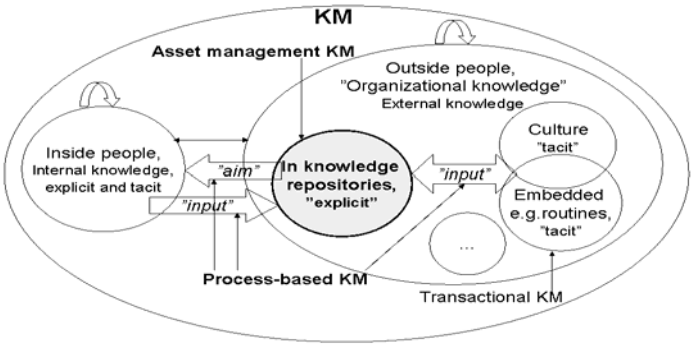

Figure 1 Different parts of KM and their relations (developed from Aggestam, and Backlund, 2007)

Knowledge derives from information (Davenport and Prusak, 1998; Wiig, 1993), and knowledge also has a function to produce new information (Schreiber et al, 1999). Activities aiming to create knowledge take place within or between people (Davenport and Prusak, 1998), but the real transformation process, when information changes to knowledge, is an individual one. Thus it is impossible to store "knowledge"; it is information that supports knowledge transformation that is stored. However, we have experienced that people regard stored information as knowledge, because this is the way it is used, and thus we can also refer to such stored information as external knowledge.

An EKR requires capturing, packaging and storing relevant knowledge. These processes take place when a knowledge repository is created for the first time in a KM implementation project, as well as every time new knowledge that has potential relevance for incorporation in an existing knowledge repository is generated. The latter is critical for having updated knowledge repositories and furthermore to maintain usefulness and trust in the repository over time. Hence, the importance of the capturing process is apparent. The Framework for IT-supported KM (FIT-KM) (Aggestam, 2006), see Figure 2, describes KM work using an EKR.

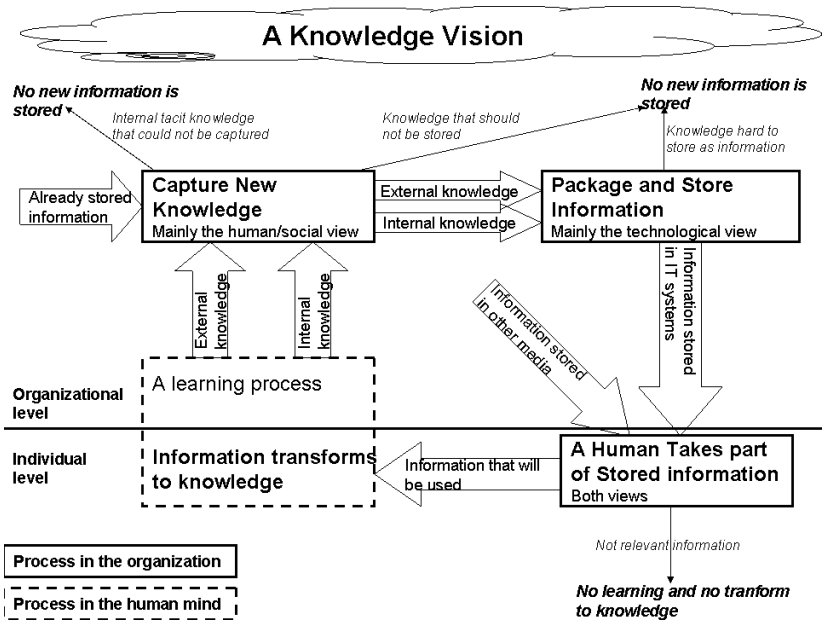

Figure 2 FIT-KM describing KM work using Electronic Knowledge Repositories (Aggestam, 2006)

One way to start KM work is to review already stored information (Gore and Gore 1999), and FIT-KM clearly indicates that this is an entrance to the process *Capture new knowledge*. The Capture process together with packaging and storing are the organizational processes in FIT-KM. *Capture new knowledge* aims to capture *new* knowledge, i.e. new compared to existing content in the EKR and probably also as compared to the consciousness of the humans in the organization. *Capture New Knowledge* uses external and internal knowledge and already stored information as input. For knowledge to be captured it must first be identified. The knowledge identified must be evaluated in order to decide whether it should be passed on to the process of packaging and storing. Both identifying and evaluating knowledge can be regarded as stages or activities included in the capture process. *Package and Store Information* uses the output from the *Capture new knowledge* process as input; i.e. identified knowledge that passed the evaluation. It aims to package and store information in such a way that it is easy to find, share, use and complement. As opposed to the capturing process, the technological perspective is dominating when packaging and storing information. The stored information is the input at the individual level. If an employee finds the stored information relevant according to both task and earlier knowledge the information will be used.

3 RESEARCH PROCESS

The goal is to develop evaluation criteria to facilitate the decision whether or not to store the knowledge identified. Successful evaluation includes managing CSF in the evaluation stage of the capture process. Thus, to achieve this goal we first identify and characterize CSF for the evaluation activity, and then develop the evaluation criteria. CSF is a limited number of success factors (Rockart, 1979). If there are too many factors, more than 4-6, they are probably too detailed and all of them are probably not critical (Avison and Fitzgerald, 1995).

In the literature, the topic of Success Factors (SF) in knowledge management work is frequently discussed (see e.g. Davenport and Prusak, 1998; Hung et al, 2005; Montequin, 2006, Storey and Barnett, 2000), but with regard to increasing the quality in an EKR this is not enough. To support the decision process of storing knowledge or not, we need knowledge and understanding about what conditions need to be met in this specific stage of the capture process. The research process included a theoretical review and a case study, and the qualitative analysis comprised six steps. Before summarizing these six steps we describe the case where our case study was performed.

3.1 The case

The unit of analysis in the case study was an EKR implementation project called *Efficient Knowledge Management and Learning in Knowledge Intensive Organisations (EKLär).* EKLär is a health care project based on the prevention and treatment of leg ulcers. Three treatment units were included in this project: Home Healthcare, Primary Care and Hospital. The project run for three years and was completed in 2007. Its main result was an EKR for learning and sharing of best practices concerning treatment and prevention methods for leg ulcers[1]. The KM approach used in EKLär, Enterprise Knowledge Patterns (EKP), combines Enterprise Modelling (EM) with organisational patterns (Stirna et al, 2006). The approach is characterised by a strong emphasis on stakeholder participation and the use of Organizational Patterns to package knowledge. The project was carried out in three phases:

The preparation phase was completed in approximately six months, and aimed to collect knowledge about the domain and obtain project approval. During this phase, data were collected via 19 interviews and 2 half a day in observations.

The implementation phase was completed in approximately fifteen months and aimed to 1) develop an EKR prototype, and 2) prepare the hospital for long term EKR maintenance. This phase involved daily efforts to develop the repository and hands-on learning to help stakeholders learn how to manage knowledge by using the EKR. Data were collected mainly at project team meetings. An average of one meeting a month was performed, with each meeting spanning four to eight hours. The meetings aimed to develop the prototype were documented by models, purpose-built patterns and detailed written notes, and the meetings about repository maintenance were mainly collected by recording, transcribing and note-taking methods. Meeting notes were summarised and sent to the participants for confirmation. Additional data was collected in the form of relevant documents and documents of similar projects from other hospitals. Initial project team meetings aimed to identify key knowledge areas for the project. This work was carried out through enterprise modelling using a participatory approach. The result was a "Knowledge map" in the form of a conceptual model. A fraction of the Knowledge map can be found in Figure 3:1.

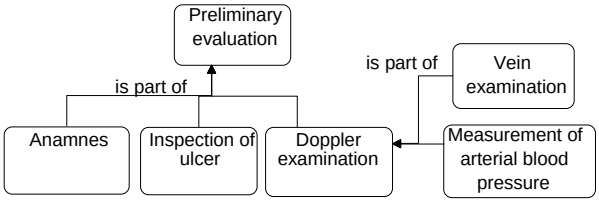

Figure 3:1 A fraction of the knowledge map (Persson, Stirna and Aggestam, 2008)

The areas identified were an integration of the knowledge needs identified in the preparation phase and hospital personnel's views of the most important knowledge to be shared and learned. On this basis the project team proceeded to capture relevant knowledge, and package and store it. As the project proceeded, nurses became increasingly independent and carried out more and more work autonomously in between monthly project team meetings. As a technological tool the project team chose an existing technical solution already in use by the hospital for other projects. An important part when preparing for long term EKR maintenance was defined as the identification of situations where key knowledge with the potential for storage might be created. Much effort was invested in order to identify these situations. Data from project meetings about repository maintenance were mainly collected by recording, transcribing and note-taking methods.

[1] The link to the developed repository is www.vgregion.se/skassarwebben

The evaluation phase was completed in approximately seven months and was carried out in parallel with the implementation phase. It aimed to test and refine the prototype EKR and raise awareness of its existence and usefulness among potential end-users. To test the repository, observations were conducted of six end-users using the EKR. In each observation the end-user was observed while attempting to solve two patient cases with the support of the repository. These observations were taped and transcribed. In analysing the observations we employed Jennex and Olfman's (2006) KM success model, seeking to identify the repository's potential for success. The results of this analysis were positive, and the EKR was therefore evaluated at this stage of the project as a success. Clearly further evaluations are needed.

3.2 The six steps included in the analysis

Our findings are based on both theoretical and empirical data. To analyze the collected data the following six steps have been carried out:

1. Summarize success factors in KM work already described in the literature. Output: an account of SF for KM work
2. Analyze the account of SF with a specific focus on how they influence the capture process. Output: An account of SF for the capture process based on theoretical data.
3. Analyze data collected in EKLär in order to identify SF that influence the capture process. Output: An account of SF for the capture process based on empirical data.
4. Analyze the two accounts of SF for the capture process aiming to extract those success factors that influence the evaluation stage. Output: An account of SF for the evaluate activity based on both theoretical and empirical data.
5. At this stage we have a large number of SF for the evaluate activity, but CSF is a *limited* number of factors. Thus, aiming to identify the *critical* SF, we conceptually analyze, organize and group the SF with regard to *how* they influence the evaluate activity as well as each other. Output: An account and a characterization of CSF for the evaluate activity. The characterization also includes a conceptual model showing factors that influence the CSF.
6. Based on the characterization of CSF we develop the evaluation criteria. Output: Six documented evaluation criteria.

To show how different data influenced our findings, we describe this including references and illustrative examples as well as quotations from the case study in a fashion similar to Orlikowski (1993) and Persson (2001). All quotations are our own translations from Swedish.

4 CSF FOR THE EVALUATE ACTIVITY

In order to enhance traceability, Section 4.1 includes a comprehensive description of how we analyzed our data with the purpose to identify CSF for the evaluate activity. Section 4.2, then, includes the CSF and a conceptual model showing how these CSF influence the evaluation of identified knowledge as well as factors that in turn influence the CSF.

4.1 A description of what data – Success Factors – that have influenced our findings

To enhance reading, we end this section with a summary where key words are italicized. In the EKLär case we explicitly discussed "How do we evaluate knowledge and related to what?" To store everything results in information overflow and problems finding the required knowledge. In EKLär, different people, i.e. from different work professions, performed the evaluation. Who did the evaluation was dependant on the perspective from where the knowledge was evaluated. It was the nurses who evaluated if the knowledge was relevant with respect to what knowledge they wanted to share through the repository. Here the Knowledge map was an important tool to evaluate against. Doctors evaluated if the packaged knowledge was correct, and they signed each chunk of knowledge

as an act of quality assurance. This division of labour was the main reason for us to identify that evaluation with respect to both relevance and correctness is a SF. Regardless of the kind of evaluation, it must be systemized and the evaluation task must be included in work role descriptions if it is to performed regularly. This is another SF. Further analysis shows that the literature supports both types of evaluation, but the difference was not as clear in the studied literature. In the following we discuss each type of evaluation separately:

Evaluate with respect to relevance: If knowledge is to be incorporated in the repository it must be in line with the purpose of the repository. This is a SF. As Davenport and Prusak (1998) put it: What business goals should the codified knowledge serve? The importance of the knowledge vision is well stated in the literature (see e.g. Remus and Schub, 2003; Wong and Aspinwall, 2004; Blodgood and Salisbury, 2001). In the EKLär case, the importance of the knowledge goal, in the form of the Knowledge map, when evaluating identified knowledge, was revealed. The users' needs that were discovered in the preparation phase in the EKLär case is an important part of the knowledge goal. Important aspects for the users are treatment material and images to compare with in order to identify leg ulcer type as well as to describe a leg ulcer. Thus, one valuable evaluate criterion in the beginning, and a SF, was that the first version of the prototype must include these. Otherwise there is a great risk that the first impression will be negative. Some illustrative quotations from the preparation phase about relevance of the material:

> "Material costs a lot of money… Good if the repository contains information about material and what material, bought by different purchasers, are equivalent. Even dressing techniques are good to find information about, sometimes you can not do it as the instruction says." … "Are we allowed changing bandage material?" … "New bandage, and alternative products" (from the interviews in the pre study).

And some about the pictures:

> "Pictures in the repository to compare with would be good." … "Good with pictures of different types of leg ulcers because when a leg ulcer is to be described it will be possible to relate to a picture." (from the interviews in the pre study)

Pictures enhance storing knowledge with regard to the tacit dimension as it is described by Polyani, 1983).

Even though legal aspects were not an issue in the EkLär project, due to the generic nature of the knowledge stored, they are likely to be so in most settings, thus being a relevant SF. If legislation prohibits storing a specific type of information, the current knowledge is not relevant for the repository. Another important evaluation criterion, and a SF, is protection (Carlsson, 2001) which concerns both value erosion and imitation by competitors. The latter was not topical in the EKLär case, because it is a project in the area of public health care. We note that legal aspects can be regarded as another perspective of protection (Aggestam and Backlund, 2007).

An EKR provides knowledge that is already captured (Chua and Lam, 2005). Thus we must capture *new* knowledge, i.e. an important evaluation criterion is what is already stored in the repository. When storing new knowledge, this can result in removing already stored knowledge or updating it. An example from the EKLär case is when, every third year, a new purchase of treatment materials is done.

Evaluate with regard to correctness: The correctness of the knowledge is a SF. In the EKLär case doctors evaluated identified knowledge with regard to correctness. This requires that the knowledge is documented, i.e. "packaged" in some way. Identified knowledge, after some initial packaging, may need to return to the capturing process; thus revealing an iterative element.

> "We do the [packaging] job and then present it to the medically responsible person who can say 'yes' or 'no'. If everything is ok, he/she signs his/her name underneath…" (nurse in the project team)

In the EKLär case the EKP approach (Persson and Stirna, 2002) has been used for packaging. After checking, the knowledge chunk went back to the nurses including comments about how to update it or, if everything was correct, the doctor's signature and date was given. Considering that people judge information on the basis of who provides it (Davenport and Prusak, 1998), this also contributed to credibility.

> "Is there any person who can quality assure all patterns or is it that way that some patterns are so complex that more than one person is needed? Do we need a doctor for doing this? Is it a role or a person who should do this job?" (nurse in the project team)

With respect to credibility it is important that a person who the users have faith in does this type of evaluation. This is a SF. The main target group is nurses in primary care and home health care who know and have faith in the individual doctors at the hospital working with leg ulcers. Therefore we decided that the person rather than the role was important and as a consequence each doctor puts his/her name on the patterns. The observations performed in the evaluation phase showed that this was a wrong decision, and we complemented with the role.

> "I wonder who this is… The role increases trustworthiness" … "I want to know who this person is." (from two of the observations in the evaluation phase)

The users of the EKR in the EKLär case, primary care and nurses in the municipality, belong to the group that Markus (2001) identifies as "Shared work practitioners". According to Markus (2001) this group selects available knowledge documents, among other things, based on the reputation of the person who contributes the document. That the current knowledge has been committed to by some sort of management, in the EKLär case, the doctors, is also important with regard to political processes. It is important to realize that individuals can act in order to reach personal objectives and that everybody does not act in a rational manner in order to reach the common objectives (Bastöe and Dahl, 1996). Political processes between different stakeholders must be managed (Chua and Lam, 2005), and authority is one among many forms of power (Bolman and Deal, 1997). In the area of health care doctors have authority.

Summary: The evaluate activity aims to select what to store. Evaluating with respect to *correctness* influences the *reliability*, and a person who the users have faith in should do this kind of evaluation. For this, *the role* is as important as *who* did it, and, from a political perspective, this is also a sign of *commitment*. Other types of evaluating concern judging whether the knowledge is *relevant* with regard to the *knowledge goal and intended users*, if it is *already stored* or not, and if it can be stored with regard to *legal aspects* and the organization's *protection policy*. One valuable evaluation criterion in the beginning is what the *end users regard as most important* to find in the first prototype of the repository. This presupposes knowledge about the users already in the beginning of the project and the need of *preparation* work including finding this out is clear. Some evaluation criteria require that the actual knowledge *is packaged* in some way, e.g. correctness, and an iterative element between the capture process and the process of package and store is revealed. All these different *types of evaluating* require different types of criteria to value against and thus require different types of competences. Different roles can be responsible for all or parts of the evaluation, but regardless of this, it must be defined which role, "who", is responsible for which part and corresponding *work role descriptions* must be accordingly revised.

4.2 CSF when evaluating if identified knowledge should be stored

Based on the analysis of SF for the evaluate activity the following six CSF have been identified:

- CSF1: The evaluate activity is included in relevant work role descriptions
- CSF2: Evaluation addressing correctness is performed
- CSF3: Evaluation addressing protection of organizational knowledge is performed
- CSF4: Evaluation addressing relevance is performed
- CSF5: Evaluation addressing redundancy is performed
- CSF6: The repository satisfies most important knowledge needs of the users

In Figure 3 we visualize how these CSF influence the evaluate activity as well as different conditions that influence the CSF.

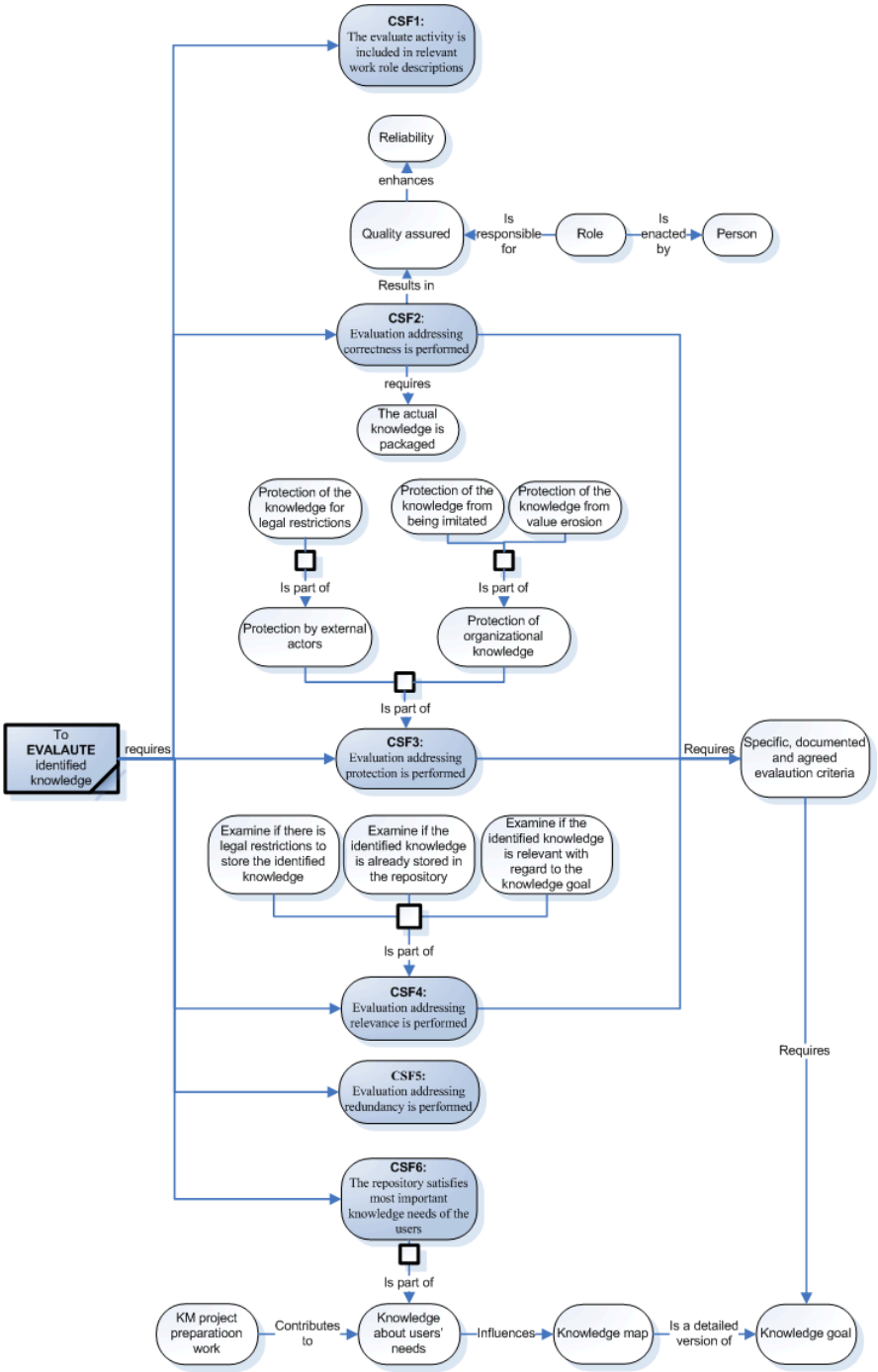

Figure 2 CSF for the evaluate activity and their influence factors

Successful evaluation includes managing CSF for the evaluate activity. Thus, we use the work presented in this section as a base when developing the evaluation criteria. These criteria are presented in the next chapter.

5 THE EVALUATION CRITERIA

Knowledge which is not relevant and correct should not be stored if reaching high quality in an EKR. This means that for knowledge to be stored, it must pass the evaluation process. The proposed evaluation criteria aim to support the decision whether identified knowledge should be stored or not.

Based on the work presented in Section 4 the following six evaluation criteria have been developed:

1. Evaluate if the identified piece of knowledge contributes to achieve the goal for the EKR. If not, it should not be incorporated in the EKR. Notably, the evaluation performed when building the EKR must also examine if the knowledge to be stored satisfies the most important needs of the users.
2. Evaluate if the identified piece of knowledge is already stored in the actual EKR. If it is stored, examine if it needs to be revised/updated according to the newly identified piece of knowledge.
3. Evaluate if storing the identified piece of knowledge enhances risk for imitation by external actors in such a way that the organization risks decreasing its competitive advantages. If this is the case, the target organization must examine if there are other ways of solving this problem as, for example, storing information concerning where the actual knowledge can be found or decreasing the rights for using the EKR.
4. Evaluate if the identified piece of knowledge is protected by external actors. If this is the case, the actual degree of protection decides whether the knowledge should be stored or not. For example, if it is against the law to store it should not be incorporated in the repository.
5. Evaluate if storing involves losing critical knowledge elements. Before deciding if storing involves losing critical knowledge elements different kinds of storing, e.g. text, pictures, or films, must be evaluated. If storing results in losing critical knowledge elements, the target organization must evaluate whether it is worth storing at all.
6. Evaluate if the identified piece of knowledge is correct. Since storing may involve losing knowledge elements this evaluation criterion, in accordance with criterion number 5, presupposes some form of packaging.

Notably, there is normally no single person that individually can perform these different types of evaluations, since different types of evaluation require different competence. For example, our interpretation is that checking correctness requires specialist knowledge. We also anticipate that checking value erosion requires specialist knowledge since this concerns to identify if, and in that case which, critical knowledge element have been dropped when storing the actual piece of knowledge. Furthermore, correctness and value erosion are tightly coupled, since value erosion may cause the knowledge not being correct anymore. To check value erosion requires that the actual piece of knowledge is packaged in some way, and the packaging can also influence correctness. Hence, we claim that evaluation addressing correctness and value erosion requires some form of initial packaging and should therefore be performed finally in the evaluation stage of the capture process.

6 FINAL REMARK

High information quality is a crucial factor for organizations' competitiveness. With the purpose to increase information quality in EKRs, this paper presents six evaluation criteria which aims to enhance the decision of whether or not to store identified knowledge in the EKR. We utilized a theoretical review and a case study to identify and characterize CSF for the evaluate activity, and then, based on these CSF, we developed the criteria. This method resulted in two contributions: the CSF for the evaluate activity and the six evaluation criteria.

All CSF for the evaluate activity, except CSF1, is covered by the presented criteria. CSF1 concerns the evaluate activity being included in relevant work role descriptions. We claim that this not a part of the evaluation, rather a prerequisite for it. Hence this CSF should not be included in the criteria. Thus, we argue that using the evaluation criteria have potential for increasing the information quality in EKRs. Future work aims to further develop the evaluation criteria and to enhance the practical use of them in order to increase information quality in EKRs. This work will include both theoretical and empirical studies. The presented criteria have their roots in the KM area. Because the criteria aim to support deciding whether identified knowledge should be stored or not, we believe that they will benefit from the literature in the fields of Decision Support System and Expert Systems. Furthermore, we plan to apply the criteria in practical KM work, and accordingly revise them.

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