

Organizing knowledge in knowledge management systems

Jong-Ae Kim¹

¹*Department of Library and Information Science, Kyonggi University, Suwon, Kyonggi, South Korea*

Abstract- Despite wide implementations of knowledge management, there is the insufficient literature dealing with the importance of a systematic framework for building a knowledge map. Although knowledge is an important asset of an organization, it is complicated to manage due to its intangible nature. This study examines the advantages of adopting a knowledge map and suggests a framework to guide the practitioners in the development of knowledge map. The framework is presented in terms of the development process, essential principles, and suggestions for the structure and terminology of a knowledge map.

Keywords – knowledge map, taxonomy, knowledge organization, knowledge management system

I. INTRODUCTION

Knowledge management has recently received wide attention from various fields including business, human resources, organizational development and information technology. Many organizations have implemented knowledge management as a systematic effort to utilize organizational knowledge thus leading to the improvement of organizational performance. Knowledge management is defined as the formal management of knowledge resources to facilitate access and reuse of knowledge that is generally enabled by advanced information technology (O'Leary 1998). Its benefits have been widely reported in the literature (Bierly and Chakrabarti, 1996; Chen, 2006; Lee and Choi, 2003; Luo & Lee, 2013; Rudawska, 2013; Sivri & Krallmann, 2015, Zheng et al., 2015).

It has been recognized that knowledge is an important asset of an organization, but it is complicated to manage due to its intangible nature. There has been no consensus on which approach is most effective to present organizational knowledge. The most frequently used approach is the presentation of a knowledge map. In the beginning of knowledge management implementation, an organization needs to develop a knowledge map that reflects its core knowledge and terminology. However many organizations tend not to have the experience on developing a knowledge map that suits to their organizational uniqueness. They had to learn by trial and error. As many organizations implemented knowledge management, they have begun to realize the importance of a systematic approach to the development of a knowledge map.

A knowledge map is a representation of knowledge available in an organization and exerts an influence on the way that the organizational members understand the structure of knowledge available to them. It plays a crucial role in ensuring that knowledge resources are shared and used in the organization in an efficient and consistent way. In practice, the knowledge map development has not been based on solid theoretical ground, but relied on ad hoc approaches in the enterprise environment. Kasten (2007) warns that relying on empirically-based knowledge structure may lead to the creation of an incomplete knowledge management system. A theoretical and methodological grounding in the practice of knowledge map development is essential in order to create a more efficient and accomplished knowledge map.

Despite the extensive literature on knowledge management, there has been insufficient research dealing with the importance of the organization of knowledge resources and the systematic framework for building a knowledge map. Although many practitioners in charge of implementing knowledge management in various organizations are in need of expert help from the knowledge organization field, there has been not much literature to guide them. Thus this study examines the advantages to be gained from adopting a knowledge map and suggests the framework to guide the practitioners in the development of a knowledge map. The framework is presented in terms of the development process, essential principles, and suggestions for the structure and terminology of a knowledge map.

II. TAXONOMIC APPROACH IN KNOWLEDGE MANAGEMENT

In the literature on knowledge management, corporate taxonomy and knowledge map have been used interchangeably. Sharma et al. (2008) distinguish taxonomy from knowledge map by defining taxonomy as “a rule-driven hierarchical organization of categories used for classification purposes with the appropriate subject headings and descriptors,” and knowledge map as “a visual aid that helps the search and retrieval process” (p.41). As a model for knowledge representation, a knowledge map presents the inter-relationships among the concepts in a knowledge management system, thus allowing the users to recognize the whole span of knowledge that the system has accumulated.

There are two different approaches to model concept relations: hierarchical and associative. In a hierarchical relation, “concepts are organized into levels where the superordinate concept is subdivided into at least one subordinate concept” (ISO 2009, p.6). An associative relation is a thematic connection established between concepts by virtue of expertise (ISO 2009). A linear hierarchical taxonomy presented in a knowledge map has limitations in some aspects. For example, the whole span of knowledge resources is not easily classified to linear hierarchical categories. However, due to its simplicity and strength in that it can provide an entire picture of organizational knowledge resources, a linear hierarchical knowledge map has been widely accepted and implemented. Among the various approaches explored to present a knowledge map in knowledge management systems, a linear hierarchical representation of the knowledge map is examined in this study.

2.1 Advantages of adopting taxonomic approach

Two different approaches have been practiced to provide the users with the access to organizational knowledge. One is to provide categorized documents in the form of knowledge map and the other is to assign metadata to the documents in order to support searching. One of the benefits of knowledge map is that it provides the users with the opportunities for the serendipity of information (Woods 2004). While the searching function supports the users in retrieving the information by entering key terms, the navigation function can help them find information when they cannot specify the key terms. In addition, a knowledge map provides the big picture of the whole span of knowledge that a knowledge management system offers. To aid the user’s effort in finding relevant information, both searching and browsing functions need to be provided. Although searching is a popular method used for finding information, browsing is also of great value in supporting the users to find information when they do not have concrete search strategies.

The taxonomic approach in organizing knowledge resources also improves the efficiency in navigation and information retrieval in a specific category. That is, it enables the users to limit the search to a specific category. It is useful especially when the search term is too general or multivocal. Grey (2006) indicates the advantages of a taxonomic approach in organizing knowledge resources in the knowledge management practice as: sharing a common language, recognizing new concepts more consistently and lifting the level of awareness, and improving internal communication. The advantages indicated by other researchers include the formalization of organizational knowledge, perceptions of relationships between knowledge, efficient navigation, and buildup of the socialization of knowledge by connecting domain experts with users (Kim, Suh and Hwang 2003).

2.2 Theoretical systems and practical systems in knowledge organization

In his eminent book on classification, Richardson (1930) divides the classification systems into theoretical systems and practical systems. The theoretical classification system traces back to the nature of human thought trying to distinguish things around them. The theoretical classification systems, whose influence on later systems can be traced, include those of Plato and Aristotle. The system of Plato explicates the systematic distributions of knowledge by dividing them into physics, ethics and logic. Later more theoretical systems were devised including Zeno, Scholastic, Bacon and Whittaker. Among these systems, the system of Bacon has exerted great influences on many modern classification schemes. It includes three main classes, history, poetry and philosophy, which are based on the characteristics of mental faculties, i.e. memory, imagination and reason (Sayers 1922). Since the system only has three main classes, its subdivision should be extended for practical applications in modern classification practices.

The practical system refers to the system of book classification. It is distinguished from the theoretical system in that it is provided with a notation (Richardson 1930). The library classification schemes have evolved from enumerative schemes to faceted schemes. The enumerative schemes consist of the schedules enumerating the subjects, so the schedules of subjects are mostly long. One of the well-known enumerative classification schemes is the Dewey Decimal Classification (DDC). The DDC is almost a replica of the “inverted Baconian” scheme, but has been adjusted to reflect modern interpretation of terms (Sayers 1922). The decimal classification systems have been widely accepted due to their simplicity and practical utility. However it has been criticized that they are not flexible enough to accommodate the emergence of unanticipated new subjects. The faceted schemes allow for combining facets according to stated principles without applying the existing schedules. Although the faceted schemes are able to represent the compound subjects systematically, they have not been widely accepted due to their complexity.

It has been criticized that many classification systems constructed up until now have not been based on solid theoretical considerations (Dahlberg 2006). The library classification schemes have not been widely adopted in knowledge management practice in that the notation used in the schemes do not provide semantic hints to the users. It has also been pointed out that the theoretical systems developed by philosophers in the past centuries are not that useful for knowledge organization in modern times (Dahlberg 2006).

III. TYPES OF DEVELOPING A KNOWLEDGE MAP

The knowledge map has been implemented in organizations for various purposes and in various forms. Some knowledge maps are built by reflecting the business processes (Sivri & Krallmann, 2015; Tserng, Yin & Lee, 2010; Yang, Xie & Zhuang, 2011; Yang et al. 2007). When using this approach, the knowledge necessary for a specific process can be easily located and shared among the users of knowledge management system. It also shows the knowledge flow along the business processes. Kang et al. (2003) distinguish the process-perspective knowledge map from the organization-perspective knowledge map, pointing out that combining the two approaches can improve the effectiveness of knowledge utilization. On the other hand the contents-perspective knowledge map which organizes knowledge by subject matter is also frequently adopted in the knowledge management practice. Sayers (1922) advocates the arrangement by subject to support better accessibility and usefulness. Some knowledge maps are designed to help locate experts and to facilitate communication with the experts in virtual communities of practice (Woo et al. 2004; Lin and Hsueh 2006).

The approaches to creating a knowledge map may also be divided into manual, automatic, and combination. The manual approach is labor-intensive, time-consuming and expensive. In the manual approach various methods such as surveys, focus groups and interviews can be used to find out the users' needs and their information seeking behavior. Although the data collected using these methods can provide some guidance to developing a knowledge map, knowledge management practitioners still need to apply the understandings of basic principles for knowledge organization.

The automatic approach helps the process of developing a knowledge map more quickly. It can be useful when the enterprise has no experience in developing a knowledge map and does not have the experts in the knowledge organization field. The automatic approach may be implemented using various methods. The commonly used techniques include statistical clustering, rule-based approach, training set and linguistic approach. In statistical clustering, a knowledge map is generated by extracting categories with similarity based on word frequency and placement. The rule-based approach is to develop clusters based on specific rules comprising if-then conditions using a sample collection. Training set is an initial example collection of documents selected to represent the subjects and to build pre-established categories. The accuracy of this method is generally proportional to the size of the training set (Lubbes 2001). Linguistic analysis adopts a syntactic approach to extract meaning from knowledge resources. However in many cases the groupings resulted from these automatic approaches do not reflect their subject similarity appropriately.

Which approach to adopt when developing a knowledge map depends on a number of factors. According to Woods (2004), the decision depends on "a mixture of the business requirement, the type, volume and volatility of the information to be managed, the skills available in-house and the budget available" (p.17). In his study, it is suggested that the automatic approach is efficient when the volatility of the information and the categories are extensive and the in-house experience is not readily available. In many cases where the automatic approach is adopted, human judgment is still necessary to increase accuracy and consistency. The combination approach that adopts both automatic and manual approaches may help improve the speed and accuracy in the development of a knowledge map.

IV. FRAMEWORK FOR THE DEVELOPMENT OF KNOWLEDGE MAP

A knowledge map plays a role as an authoritative mechanism that enables the terms and relationships of organizational knowledge to be shared and commonly understood by the members from different parts of the organization. The knowledge resources of the organization become more visible and accessible by being represented via a knowledge map. It allows for browsing the structured taxonomy of the intellectual capital that the organization has. The increased visibility of knowledge resources provides organizational members with the increased opportunities to discover what they need.

It is crucial to address the issues of how to best organize knowledge resources and provide access to them. To represent the systematic structure of knowledge resources and to reduce the user's cognitive load, a knowledge map needs to be consistent. It should also be designed with well-considered usability characteristics so that users can navigate easily to find the information they need. Taxonomies in the corporate environment show some different aspects from taxonomies in traditional biological and library sciences. Unlike the traditional classification schemes, a knowledge map adopted in the corporate environment needs to be more flexible for its practical purposes. When developing a knowledge map, the organizational goals should be considered in order for the knowledge management implementation to contribute to the success of the organization.

4.1 Process of developing a knowledge map

The process of developing a knowledge map involves multiple steps. It includes organizing a team, analysis of organizational knowledge, development of knowledge map, refinement, and maintenance.

4.1.1 Organizing a team

The development of a knowledge map requires the involvement of multiple stakeholders, so oftentimes it is conducted in a collaborative project. It requires both the expertise in information science especially in the field of knowledge organization and the expertise in the specific domain to be mapped. It is helpful to organize a project team including the representatives from various parts of the organization. It enables to capture knowledge resources across the organization and to eliminate a bias in the design of knowledge map. The domain experts better understand the characteristics of knowledge resources of the organization and the business processes to which the knowledge resources are applied. On the other hand the experts in library and information science can contribute to the process by coordinating the detailed elements of the knowledge map by applying the essential principles for knowledge organization.

4.1.2 Identifying and analyzing organizational knowledge

The next step is to identify and analyze both explicit and tacit knowledge of the organization. Locating organizational knowledge often involves the inspection of stages of the business process. The techniques that can be used to locate and extract organizational knowledge include questionnaires, interviewing, analysis of various internal and external documents, analysis of knowledge resources stored in information systems, intensive discussion, brainstorming, nominal group techniques, focus groups, and task environment analysis (Kim et al. 2003). A well-defined scope of organizational knowledge makes the process of identifying categories more manageable. It should also be determined that the scope of the knowledge map will cover either the level of the entire organization or the level of a specific part of the organization. One of the useful approaches to take in analyzing organizational knowledge is the Boston Box recommended by Drew (1999). The Boston Box indicates four quadrants to be considered to ensure that a complete coverage of organizational knowledge is identified. The four quadrants include (1) what we know we know, (2) what we know we don't know, (3) what we don't know we know, and (4) what we don't know we don't know. This approach enables to identify and analyze the strengths and deficiencies that the organization has in terms of knowledge resources.

4.1.3 Developing a draft knowledge map

The issue of how well organizational knowledge is represented is a key factor in creating a successful knowledge map. Although various approaches have been experimented and adopted to develop knowledge maps, their comparative superiority has not been proven. There has been no standardized method to develop a knowledge map. It is not a simple task to get the whole span of organizational knowledge to be fitted into a limited number of categories in a knowledge map. The creation of more useful and easily navigable knowledge map can be achieved by accommodating the user's needs and cognitive patterns. The structure of knowledge map should be logical and also practical to meet user needs. Kibby (2002) emphasizes "the capacity of a categorization at one level to suggest to its user what may be found at lower level" in a knowledge map. Another important issue in developing a knowledge map is to use common terminology that is accepted throughout the organization.

The creation of knowledge map can be conducted using either a top-down approach or a bottom-up approach. The top-down approach is to identify the relationships among concepts in the field and pre-define knowledge structure of the field. The bottom-up approach is to cluster knowledge resources based on their similarity and extract categories representing the structure of organizational knowledge properly. In either approach it is important to maintain consistency in applying the basic principles for knowledge organization.

4.1.4 Refining a knowledge map

During the refinement process the participation of domain experts and users is essential in validating and revising a knowledge map. The refinement can be conducted through a review of domain experts and a walkthrough with users. By using the walkthrough method, it can be observed how users navigate the knowledge map to find the content they need. The categories of the knowledge map should fit well to the users' cognitive understandings. It can also be helpful to test the categories by conducting a test classification using a sample of knowledge resources in the organization to examine whether the knowledge map enables the resources to be classified without difficulties. Once the refinement is completed, it should be presented effectively in the interface of the knowledge management system to assist the users to easily find knowledge resources they need.

4.1.5 Maintenance of a knowledge map

Any subject fields tend to change continuously. Thus it requires occasional adjustments of a knowledge map and sometimes necessitates significant changes. A knowledge map should be monitored and updated consistently to better serve user needs as the organizational context and business priorities change. The refinement of a knowledge map is an iterative process throughout its lifecycle. The maintenance of the knowledge map can sometimes be a more difficult task than its creation. An organization implementing knowledge management needs to establish a systematic maintenance process to keep the knowledge map useful and effective. The maintenance process should be taken seriously because the view of the relationships between knowledge domains in the enterprise may change as the knowledge map changes and evolves.

4.2 Guiding principles for knowledge organization

The need for understanding the theories and principles of knowledge organization is essential in creating a knowledge map. By complying with the basic principles for knowledge organization, knowledge management practitioners can avoid using the characteristics that may damage the utility of a knowledge map. According to Tennis (2005), a well-designed classificatory structure should provide hospitality, warrant, and fulfillment of user needs. The hospitality allows new concepts to be inserted, and warrant, which may be justified by using controlled vocabulary, enables users to find information more precisely. Reflecting user needs is also essential in designing classificatory structures.

Common sense canons in classification schemes suggested by Ranganathan (1967) also provide some guiding principles in creating a knowledge map. Although these canons were introduced decades ago, they are not well-recognized by knowledge management practitioners. Considering the importance and utility of these essential principles, they are revisited in this article. Ranganathan explained four canons regulating the work in designing a classification scheme in terms of characteristics: differentiation, relevance, ascertainability, and permanence. Differentiation implies that a characteristic adopted as the basis for the classification should have a differentiating element generating at least two classes. Relevance denotes that a characteristic adopted as the basis for the classification should be relevant to the purpose for which the classification scheme is designed. Ascertainability means that among many relevant characteristics only the characteristics that are ascertainable should be applied for a classification scheme. Permanence implies that a characteristic adopted as the basis for the classification should remain unchanged unless the purpose of classification changes.

In terms of array of classes, four canons were suggested by Ranganathan: exhaustiveness, exclusiveness, helpful sequence, and consistent sequence. Exhaustiveness means that the classes in an array of classes should be exhaustive enough to embrace the entire body of knowledge they represent in the classification scheme. Sayers (1922) suggests that the exhaustiveness does not mean every topic of all knowledge that the scheme covers should be named in the scheme, but that it should provide a possibility to insert any new topic without dislocating the sequence. In addition, Sayers (1922) suggests the need of a generalia class to cover those works that deal with composite or miscellaneous subjects, thus avoiding the problems of being classified into any one single class. Exhaustiveness should be satisfied in the schemes covering specialized fields as well as general schemes. The canon of exclusiveness implies that the classes in an array of classes should be mutually exclusive and not overlap. In order to achieve this, a consistent characteristic should be used as the basis for the classification. The canon of helpful sequence conveys the principles in deciding the sequence of the classes in an array of classes. The most effective sequence of the classes may not be always the same for various users or contexts. The canon of consistent sequence implies that the sequence of the classes in different arrays should be parallel to secure the consistency thus minimizing the user's cognitive load.

4.3 Structure of a knowledge map

A successful knowledge map should be practical, and a simple structure based on a straightforward classification scheme will better serve to achieve that purpose. In many cases a knowledge map is implemented in a visual representation of hierarchical relationships to aid the user's recognition of both the entire structure and the detailed categories. A well-structured knowledge map can increase the user's understanding of the world of knowledge in the field. It allows the users to navigate the entire body of knowledge resources easily. When designing the structure of a knowledge map, it is crucial to help the users easily recognize both the entire structure of the knowledge map and the specific point where they are located.

In a linear knowledge map, the task of classification involves mapping a multidimensional world of knowledge to a linear hierarchy. One of the most important issues in developing a knowledge map is to ensure a balance between the breadth and depth of categories. The decision on how many levels deep a knowledge map should be divided into depends on the purpose of the scheme. The breadth and depth of the knowledge map is also closely related to the level of specificity of the categories. It is challenging to determine the proper level of detail to represent

organizational knowledge effectively and to meet user needs. If a knowledge map has too many layers in terms of depth, the speed of browsing may slow and the users may be lost while navigating the categories. The depth of a knowledge map strongly affects the user's cognitive load. Too many layers require the user to maintain cognitive strain. On the other hand if the breadth of the knowledge map is too expansive, the users will experience difficulties in browsing the categories to determine the contents of the categories.

Although there is no consensus regarding the breadth and depth of categories in a knowledge map, many researchers suggest that breadth can be more acceptable than depth in terms of reducing the user's cognitive load. Roberts-Witt (1999) suggests that broad, flat taxonomies are more effective than deep vertical ones. A report from the Delphi Group (2002) recommends a flat taxonomy going no more than three to six levels deep to support the efficiency of information retrieval. At the same time the breadth of categories of a knowledge map should be limited in order to ensure that the user can easily speculate the scope of the entire body of knowledge resources. The report suggests 10-15 categories at the top level. It may be helpful to establish recommended guidelines for the breadth and depth of the knowledge map in an organization to ensure that it is controlled properly in the maintenance process.

4.4 Terminology

The terminology used in a knowledge map should be commonly understood across disciplines in an organization. It is a challenging task to elicit commonly agreed terminology because it is usual to use different terminology to express the same meaning in various disciplines across an organization. Given this, the need to standardize the terms presented in a knowledge map cannot be overemphasized. It is essential to standardize vocabularies in order to promote consistent understandings among organizational members and to improve communication in the organization. For the standardization of terminology, it may be a useful approach to adopt an industry specific thesaurus to a knowledge management system.

The approach to eliciting commonly agreed terminology in the development of knowledge map requires further research. A consistent approach to eliciting concepts with semantic agreement and to naming the category terms is essential. It helps optimize effective communication, which is a cornerstone for the successful outcome of a knowledge management system. One of the essential principles for naming the categories of a knowledge map is that they should be intuitive to allow the users to easily understand the contents of knowledge resources contained in the categories. Also the terms used as category names in a knowledge map should be parsimonious to avoid the user's cognitive load. Sayers (1922) emphasizes the importance of using the terms coherently throughout the scheme and using ones with invariable meanings.

The ISO (2009) principles for term formation that provide general guidance to systematizing terminologies may be applied to the development of knowledge map. The principles include transparency, consistency, appropriateness, linguistic economy, derivability, linguistic correctness, and preference for native language. Transparency implies that the concept of a term can be inferred without referring to a definition. Consistency refers to a coherent terminological system that is not arbitrary. For appropriateness, established patterns of meaning should be complied. For linguistic economy, concise terms should be preferred. However, when linguistic economy damages the accuracy of the concept, the decision should be made based on practicality. The ISO principles also recommend using the terms that are linguistically correct and expressed in native language, and that allow derivatives.

V. CONCLUSION

There is no definitive way to develop a knowledge map in the knowledge management implementation. Every organization must deal with each process of the development cycle to best serve its unique needs. Although an industry-specific knowledge map can be adopted, a customization process is needed to address the needs of different environments. The nature of knowledge map that should represent the uniqueness of an organization does not allow its development to be conducted entirely by an agent from outside of the organization. Thus the participation of the representatives from various disciplines within the organization is necessary. The basic principles suggested in this study may guide knowledge management practitioners when they need to make decisions in the design stage of the development process.

Further research is needed to assist knowledge management practitioners to organize the intellectual capital in their organizations more effectively. The research agenda includes the usability analysis of knowledge map representation. A knowledge map can be presented in various forms such as hierarchical folder, tree, star, and ring. Inspecting user preferences for each of the forms may contribute to the creation of a more effective knowledge map. The usability analysis is crucial in that a knowledge map needs to fit the needs of users as well as the organizational goals.

VI. REFERENCE

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