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Knowledge Organisation Systems in Digital Environment

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Abstract

Purpose – *The purpose of this paper is to review the literature about knowledge organisation systems in digital environment.*

Design/methodology/approach – *This paper is based on the published literature discussing various knowledge organisation systems in library and business environment. The survey is based on free text search for the terms: Knowledge organisation, Knowledge organisation systems, Knowledge organisation tools, Thesaurus, Ontology, Taxonomy, Folkosonomy, Topic maps in various databases (Emerald, Taylor & Francis, Wilson web, Science Direct, Wiley online), and Google during December, 2011. Besides online databases some articles were identified from conventional journals and books. After scrutiny the relevant articles dealing purely with the subject of knowledge organisation were classified and presented under five categories: Thesauri, Ontologies, Taxonomies, Folksonomies, and Topic maps.*

Findings – *Knowledge organisation systems/tools, which differ in complexity, composition, and function, can provide better access to digital collections.*

Originality/value – *The paper provides a review of the application/status of knowledge Organisation systems/tools in digital environment and brings together topics previously reported on in segregation.*

Keywords- *Knowledge organisation, Knowledge organisation systems, Knowledge organisation tools, Thesaurus, Ontology, Taxonomy, Folkosonomy, Topic maps.*

Paper Type – *Literature Review*

Introduction

The classification and indexing activities witnessed a number of developments during the late 19th and early 20th centuries known today as knowledge organisation **(Dousa, 2010).** The most important of these was the emergence of the idea that documents could be decomposed not only into smaller bibliographical units (as, for example, a periodical into articles or a book into chapters), but also into yet smaller information units (such as, for example, the concepts or facts discussed in discrete passages within a text) and that, once identified, these information units could be reconfigured in new arrangements that would facilitate their retrieval **(Metcalfe, 1957; Frarey, 1953).** In the nineteenth century, **Panizzi (1841), Cutter (1876), and Dewey (1876),** developed very pragmatic tools (i.e., catalogs and classifications), explaining as they did so the principles by which their tools were constructed **(Smiraglia, 2002).** The contribution of Paul Otlet (1868–1944) and Julius Otto Kaiser (1868–1927) to the field of Knowledge organisation is also remarkable and often considered as pioneering **(Dousa, 2010)**. Many western scholars however trace the origin of

knowledge organisation to Aristotle who first attempted information organisation, and to the Swedish scientist Linnaeus the first system for categorising the natural world **(Woods, 2004)**. **Sharma, Foo, and Morales-Arroyo (2008)** report that the ancient civilizations within China, India and the Mid-East in fact organized their knowledge, particularly related to philosophy, government and medicine, carefully for the purpose of transfer and re-use. Knowledge Organisation (KO) as a field of study is concerned with the nature and quality of such knowledge organizing processes as well as the knowledge organizing systems used to organize documents, document representations and concepts **(Hjorland, 2008).** Knowledge Organisation (KO) is about activities such as document description, indexing and classification performed in libraries, databases, archives etc. These activities are done by librarians, archivists, subject specialists as well as by computer algorithms **(Hjorland, 2008).**

The term knowledge organisation system encompasses all types of schemes for organizing information and for promoting knowledge management. These include taxonomies, classification, clustering and categorization schemes that organize materials at a general level, subject headings that provide more specific access, authority files that control variant forms of key information, such as geographic names, highly structured vocabularies, including thesauri, ontologies, and coding schemes, and less traditional tools, such as semantic networks and word nets **(Haravu & Neelameghan, 2003; Zeng & Hodge, 2011).**

The purpose of the present study is to review the literature about knowledge organisation systems in digital environment. This paper is based on the published literature discussing various knowledge organisation systems in library and business environment. The survey is based on free text search for the terms: Knowledge organisation, Knowledge organisation systems, Knowledge organisation tools, Thesaurus, Ontology, Taxonomy, Folkosonomy, Topic maps in various databases (Emerald, Taylor & Francis, Wilson web, Science Direct, Wiley online), and Google during December, 2011. Besides online databases some articles were identified from conventional journals and books. After scrutiny the relevant articles dealing purely with the subject of knowledge organisation were classified and presented under five categories: Thesauri, Ontologies, Taxonomies, Folksonomies, and Topic maps.

Thesauri

Thesaurus is one of the most familiar Knowledge organisation Systems. The classic meaning of a thesaurus is a kind of dictionary that contains synonyms or alternative expressions for each term, and possibly even antonyms **(Hedden, 2008a).** Subject classifications and thesauri have

become more important than ever in the Web environment **(Hawkins, Larson, & Caton, 2003). Hedden (2010)** explains that a thesaurus could be thought of as having the features of taxonomy with the addition of associative relationships, thus allowing for greater degree of structural complexity. It supports not only hierarchical relationships but also associated term relationships, cross-references from non preferred ('used for') terms, and the additional option of notes for each term **(Hedden, 2008b). Aitchison and Clarke (2004)** while tracing the history of thesaurus evolution stress the need of updating international standards for thesauri to ensure its role in effective web searching and navigation in the future. **Martínez (2007)** also stresses the need to review the thesaurus standards and the authority guidelines, in order to standardize references, abbreviations, and mark symbols. Moreover findings suggest that there is a need to raise awareness about the use of thesauri for the retrieval over networks and to try and build a consensus on the utility of subject keywords **(Fenton, 2010). Binding and Tudhope (2004)** suggest the use of a thesaurus in resolving access problems that arise when users 'search terms' do not match 'indexing terms.' **Tudhope, Binding, Blocks, and Cunliffe (2006)** argue Thesaurus-assisted retrieval systems have potential for multi-concept descriptors, permitting very precise queries and indexing. **Garrod (2000)** believes that the second edition of the UNESCO Thesaurus can be used successfully to control subject indexing in an archival context, provided that it is approached as a template and not as a definitive source.

Saarti and Hypen (2010) describe the creation of Kaunokki - the Finnish fiction thesaurus, and its development into the Kirjasampo-SAHA web service for readers and librarians, to meet challenges of information management and retrieval of fiction works. **Kumar and Nikam (2011)** describe the design and development of a machine-readable thesaurus, specifically for Yoga using UNESCO's WINISIS software. The system permits searching terms and navigation through hypertext linking to equivalent term, hierarchical term, associative term and Sanskrit-English Yoga Glossary created using MultiTes. **Neelameghan (2009)** also used UNESCO's WINISIS software for the design and development of a thesaurus for tuberculosis (TTHES) containing 2762 descriptors. **Shiri, Ruecker, Anvik, and Rossello (2006)** report the development of a visual interface for multilingual thesauri to support thesaurus-based browsing and searching of multilingual digital collections. With a view to investigate the ways in which end-users perceive a thesaurus-enhanced search interface (in particular thesaurus and search interface usability) through a survey on thirty academic users it is found that interface usability is a factor affecting thesaurus browsing/navigation and other information searching behaviours **(Shiri & Revie, 2005)**. **Neelameghan**

and Raghavan (2009) present an overview of interfacing and mutual synergy between Tamil studies and knowledge organizing tools while designing and developing a Tamil-English bilingual information retrieval thesaurus for the digital library of the Central Institute for Classical Tamil, Chennai.

Ontologies

Ontology is the term referring to the shared understanding of some domains of interest, which is often conceived as a set of classes (concepts), relations, functions, axioms and instances **(Sharma, Foo, & Morales-Arroyo, 2008)**. Ontology is originally a branch of metaphysics concerned with the nature and relations of being and the categorical structure of reality. Categories are the most fundamental things that exist or may exist in a domain of discourse. Ontology studies such categories **(Kent, 2003)**. In the context of Knowledge Management, Ontology can be simply defined as a formal, explicit specification of a shared conceptualization **(Gruber, 1993)**. **Gokhale (2009)** defines Ontology as a collection of concepts arranged in a hierarchy of categories, combined with the relationships between those concepts, in order to reflect an area of knowledge. According to **Noy and McGiness (2001)** ontology defines a common vocabulary for researchers who need to share information in a domain. It includes machine-interpretable definitions of basic concepts in the domain and relations among them. Ontologies provide a simplified and explicit specification of a phenomenon that we desire to represent **(Gruber, 1995).** To **Kim (2005)** Ontologies are domain theories which specify a domain specific vocabulary of entities, classes, properties, predicates, and functions as a set of relationships that exist among those vocabulary terms. Ontology provides a vocabulary for representing knowledge about a domain and describing specific situations therein. Ontologies are specifications of discourse in the form of a shared vocabulary. They can differ by developer and industry **(O'leary, 1998).** According to **Kent (2003)** the word ontology comes from the Greek–it is constructed from the prefix ontos that means "being" or "existence" and the base logos that means "to reason." The expressions in ontology use a language containing the relevant predications (entity and relation types). **Mcguiness (2001)** believes that Ontologies "emerged from academic obscurity into mainstream business and practice on the Web," expanding from the research level of knowledge representation, to applied fields such as knowledge bases, new methods of software engineering, or information brokering based on metadata for knowledge domains **(Cordeiro, 2003).**

Ontologies or specifically, Web Ontologies contribute to provide an adequate solution in knowledge representation. They enable the sharing

of uniform structures for classifying knowledge regardless of the implementation language or the syntax used to represent it **(Loia, 2010).** Ontologies provide the structure to facilitate drilling down in the frameworks to provide increasing levels of detail in the best-practices knowledge bases **(O'leary, 1998).** These are complex information objects, which can contain millions of concepts in complex relationships **(Ahmad & Colomb, 2007). Kim (2005)** argues that Ontologies are suitable for implementing the semantic Web, a new technology which attempts to achieve effective retrieval. **Almeida and Barbosa (2009)** advocate that once assessed as to its content, ontology may provide benefits to corporate communication and, therefore, provide support to knowledge management initiatives. Ontologies provide a common vocabulary to support the sharing and reuse of knowledge. Fundamentally, ontologies are used to improve communication between humans or computers **(Kim, 2005)**. **Choi (2008)** concludes that if complemented by Ontologies, Faceted Classification could be more usefully accepted on the Web, with increased conceptual expressiveness among facets. **Kim and Beck (2006)** found that, of the two systems (Thesaurus & Ontology) studied, an ontology provides the better representation of domain knowledge and a greater power for reasoning based on the underlying representation, which could improve searching for agricultural documents. **Fonseca and Martin (2005)** conclude that information system ontologies should take into consideration a perspective of the philosophy and history of science. **Kim, Rieh, Ahn, & Chang (n.d.)** conducted a comparative experiment in which the performance of an ontology-based system was compared with that of web search engines. The results indicate that the ontology-based system can be used not only to improve precision but also to reduce search time. **Yi (2008)** found that a Topic Maps-based ontology information retrieval (TOIR) system has a significant and positive effect on both recall and search time, compared to a thesaurus-based information retrieval (TIR) system. **Oh, Lee, Park, and Yi (2005)** found that ontology-driven knowledge organisation based on topic maps provides meaning and structure to data. **Kim (2005)** argues that major difficulty in the ontology-based approach is the extra work needed in creating the ontology and the detailed annotations

Khoo, Na, Wang, and Chan (2011) report the development of disease-treatment ontology to model and represent treatment information found in medical abstracts. Treatment information extracted from medical abstracts and medical articles can then be encoded in this ontology and used for information retrieval, question-answering, summarization and knowledge discovery. **Kim (2005)** describe the design and implementation of an ontology-based Web retrieval (ONTOWEB) system and compare the performance of the proposed system with that of

Internet search engines in terms of relevance and search time. The study shows that Ontologies can be used not only to improve precision, but also to reduce the search time. **Qin and Stephen (2001)** have described the process of converting vocabulary into ontology for information organisation.

Taxonomies

Taxonomy originally was developed as a tool for classifying biological organisms. In biology, the assumption is that more homologies two organisms share, closer they must be in terms of evolutionary distance **(McKelvey, 1982)**. **Chandra and Tumanyan (n.d.)** state that Taxonomy as a tool is applied for information conceptualization, organisation, and structuring; not only in biological science, but also in Chemistry, Organisational Science, Manufacturing Systems, and many other fields of study. **Graef (2001)** defines taxonomy as system for naming and organizing things into groups that share similar characteristics. To **Boeri (2004)** Taxonomy is a logical organisation of information categories. **Roberts (1999)** defines taxonomy as a structure that provides users with guidance showing groupings that can emerge from information in many different patterns.

Plosker (2005) argues that Taxonomies are based on the long-established world of controlled vocabularies, perhaps the core of information science. Using taxonomy in the Web search has been proved to be useful to improve the search precision **(Pahlevi & Kitagawa, 2005)**. **Samler and Lewellen (2004)** argue that Taxonomies rationalize the search process and allow users to achieve a greater level of precision and recall. According to **Corcoran (2002)** taxonomies advance information search and retrieval by providing powerful browsing capabilities based on structured content organisation and access via point-and-click directories or menu selections. Their hierarchical data relationships allow users to easily broaden or narrow searches as well as to look for related information. **Holgate (2004)** stresses that to deliver relevant business impact, taxonomy must provide the structure for the business to classify their data and content so that ongoing business operations and goal attainment can be described and reviewed. According to **Lehman (2003)** taxonomy should reflect the organisation's purpose or industry, the functions and responsibilities of the persons or groups who need to access the content, and the purposes/reasons for accessing the content. **Blackburn (2006)** stresses the need of understanding organisation, the needs of the users and application of taxonomy before choosing a taxonomy type. If the design doesn't meet the needs of the users; it will not be used.

The terms of a well constructed taxonomy can be used to advantage by on-line searchers who would like to make meaningful use of the subject headings as broad limiting terms in searches (Hawkins, **Larson, and Caton, 2003). Sharma, Foo, and Morales-Arroyo (2008)** provide a conceptual framework for developing a corporate taxonomy and conclude that corporate taxonomies which are designed to facilitate knowledge audits lead to greater organisational impact. **Uddin and Janecek (2007)** developed a framework and implemented a prototype faceted classification system based on Ranganathan's faceted classification by using a collection of 65 web documents culled from a typical higher education and research institute, The Asian Institute of Technology (AIT) in Thailand. The system provides an alternative but convenient structure for organising and finding information content. **Lin and Chan (1999)** developed a device called 'Knowledge Class' as a framework to integrate information organising methods and advanced web technology, facilitating information organisation based on hierarchical structures similar to those used in thesauri and classification schemes. McGregor (2005) report the implementation of taxonomy to improve subject access to American Medical Association's Journals' Websites. The taxonomy based on 53 general topics derived from established specialties arranged in alphabetical order and subdivided in 374 topics and subtopics are mapped to equivalent MeSH terms in the MeSH trees. **Chaudhry and Goh (2005)** used classification scheme as taxonomy category source for a business consulting environment taxonomy.

The other tools which are discussed in the literature alongside the taxonomies, Ontologies and thesauri include: Folksonomies and Topic Maps.

Folksonomies

Folksonomy, a free-form tagging, is a user-generated classification system of web contents that allows users to tag their favorite web resources with their chosen words or phrases selected from natural language. These tags (also called concepts, categories, facets or entities) can be used to classify web resources and to express users' preferences. Folksonomy-based systems allow users to classify web resources through tagging bookmarks, photos or other web resources and saving them to a public web site like Del.icio.us. **(Noruzi, 2006)**. Folksonomies permit actors to describe documents with subject headings called "tags," without regard for conventional rules **(Peters & Stock, 2007). Keshet (2010)** argues that integrating tree-like taxonomies with Folksonomies, or in other words, generating a naturalized structural order of objective relations with social, subjective classification systems, will create a vast range of hybrid

knowledge. **Reamy (2007)** echoes that if Folksonomy tag clouds are combined with a central team of editors or taxonomists (even Wikipedia has taken the plunge), they can be a valuable tool to both keep a taxonomy up-to-date, and to make the experience of adding metadata easier and more enjoyable.

Topic Maps

Topic maps are a formal way to declare a set of topics and then to provide links to documents or subdocument nodes that address the topics. In other words, they are a way to declare a set of labels for topics, and then to point to places where those topics are discussed and addressed **(Trippe, 2001)**. According to **Riesland (2004)** Topic Maps are based on traditional indexing concepts with knowledge structures (topics and associations or relations) that point to information resources (occurrences, similar to references in an index). The key concepts of topic maps are; Topic, Occurrences, and Associations. Topic and associations are the roles of ontology and the concept of occurrence borrowed from topic maps **(Topic Maps, 2000). Adams (2002)** argues that Topic maps function as a super-sophisticated system of taxonomies, defining a group of subjects and then providing hypertext links to texts about these topics. **Pepper (2002)** states that Topic maps provide an approach that unites the best of several worlds, including those of traditional indexing, library science and knowledge representation, with advanced techniques of linking and addressing. Topics maps are the equivalent of the traditional back-of-the book index in the world of electronic information **(Pepper, 2002)**. Since topic maps are intended to exist in separate documents, and since they don't require the source documents to be changed, they allow the information designer to create many views of the same data **(Trippe, 2001)**.

Conclusion

The organisation of knowledge resources is not a new phenomenon. The history of knowledge organisation can be traced back to Aristotle, Linnaeus, and Darwin. Knowledge organisation systems are used to organize materials for the purpose of retrieval and to manage a collection. A KOS serves as a bridge between the user's information need and the material in the collection. With it, the user should be able to identify an object of interest without prior knowledge of its existence. Whether through browsing or direct searching, whether through themes on a Web page or a site search engine, the KOS guides the user through a discovery process. In addition, KOSs allow the organizers to answer questions regarding the scope of a collection and what is needed to round it out (Hodge, 2000). All of these Knowledge organisation

systems/tools, which differ in complexity, composition, and function, can provide better access to digital collections.

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