An Exploratory Study of Information Systems Subject Indexing

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Abstract

The motivation for detailed study of information systems research subject indexing schemes is explained, along with an analysis of two indexing schemes proposed for use in the area. A number of reference disciplines are examined for their ability to provide insights and analysis approaches.

Keywords

MISQ: AI0106 [Research Methodology] Exploratory study; HA0902 [Types of Information Systems] Information search and retrieval

CCS: H.3.1 [Information Storage and Retrieval]: Content Analysis and Indexing – Thesauruses General Terms: Standardization, Theory

INTRODUCTION

Since 1995, John Lamp has been maintaining a resource on the world wide web (WWW) whose basic aim is to provide a central point from which academic authors publishing in the information systems domain can obtain information on the publications operating in that domain. (Lamp, 1995) The database now contains information on 260 journals, and was accessed 4386 times in April 2003.

As the number of journals included in the database increases, the difficulty of identifying suitable journals from within the database increases. There is a basic searching facility that simply matches a keyword to entries in the database, but, in common with most text searches implemented on a relational DBMS, there is no facility for maintaining result sets and refining searches through the manipulation of result sets. (Ramakrishnan & Gehrke, 2003)

A number of users have asked whether it would be possible to categorise the journals according to their publication area. In January 2002, John Lamp asked for input from information systems academics on this issue on the ISWorld mailing list. (ISWorld, 2002) The responses are at Lamp (2002). As well as attracting responses from readers and researchers in the area, a number of journal editors also responded. There was general support for providing some sort of categorisation of the journals, but a number of responses questioned whether the current MISQ categories developed by Barki et al (1988, 1993) would provide appropriate terms for categorisation.

One respondent, the editor of a journal himself, suggested that the following items would be needed: length of paper, target audience, review and publication process, time to publication, delivery mode, preferred research methods, article types preferred, style, research interests of the editorial group. (Peffers, 2002)

On the basis of this feedback, it was decided to embark on an investigation of the whole question of categorisation of information systems research publications with a view to developing a means by which information systems journals could be categorised.

RESEARCH QUESTION

The central question to which I am seeking answers is:

- How can information systems research journals be categorised in a manner useful to researchers?

This leads directly to the question:

- What attributes of an information systems research journal do researchers need to have categorised?

The information systems research domain is broad, fragmented and rapidly evolving. This raises a number of lesser but vitally important questions:

- How can a categorisation scheme be devised to accommodate the differing perspectives of information systems researchers?
- How can such a categorisation scheme be effectively maintained to ensure its continuing relevance?
- How can the categorisation of an item be maintained to ensure the continuing visibility of that item to researchers?

Identification of the full range of attributes will require information gathering from information systems researchers and journal editors. However, at the core of any such set of attributes must be the categorisation of research according to the subject domain of that research.

SUBJECT CATEGORISATION SCHEMES

A valid starting point to the investigation of subject categorisation schemes would be an examination of existing schemes. Existing general categorisation schemes used by libraries, such as the Dewey Decimal Classification (Dewey, 1989) and the Library of Congress Subject Headings (Library of Congress Cataloging Policy and Support Office, 1995) can be excluded as being too general for this purpose.

Special purpose categorisation schemes, or thesauri, have been created for a number of purposes. This may be for use in a particular area, such as women's health (George, 1991), aged care (Hay, 2001), a particular country (McKinlay, 1981) or for specialist databases (Walz, 1995; National Library of Australia, 2000)

Of the 228 currently published journals with instructions to authors accessible from the Information Systems Journals Database, 192 either don't mention keywords, or give extremely vague instructions ("don't use plurals", "don't use overly commonplace terms", "use American spellings"). Twenty, mainly published by the Association for Computing Machinery (ACM) or the IEEE Computer Society (IEEE), use the ACM Computing Classification System or an extended version of it devised by IEEE. Two journals, *MIS Quarterly* and *Journal of Informatics Education & Research*, use the MISQ scheme. Eleven journals have their own schemes, some of which are simplistic, and some are very elaborate. Three journals use categorisation schemes devised by other authorities, reflecting their multidisciplinary nature. A number of other special purpose categorisation schemes appropriate for the purposes of this investigation also exist.

This paper describes the ACM and MISQ schemes in general terms. We then propose a direction for the detailed investigation and comparison of categorisation schemes.

The ACM Computing Classification System

The Association for Computing Machinery, Inc (ACM) Computing Classification System (CCS) (ACM 1998a) was devised in 1982 and was updated in 1983, 1987, and 1991. A major revision was published in 1998 (ACM 1998b). The CCS is maintained by the ACM Classification Update Committee.

The CCS is a tree based categorisation scheme with three alphanumeric coded levels that aim to accurately reflect the essential structure of the computer science and information systems disciplines over an extended period. At level two and three of the CCS each category has *general* and *miscellaneous* categories. At the fourth level of the tree, un-encoded subject terms are used to allow for new developments in the field. In addition to these tree based categories there are also sixteen general terms which act as modifiers to the tree based categories.

Guidance is provided by ACM (1998c) on the correct method of assigning appropriate categories to an item. According to these guidelines an appropriate categorisation for this document would be H.3.1 [Information Storage and Retrieval]: Content Analysis and Indexing – Thesauruses General Terms: Standardization, Theory.

Tables 1 though 4 show the four levels of the tree based CCS terms used to arrive at the above categorisation.

A	General Literature
B	Hardware
C	Computer Systems Organization
D	Software
E	Data
F	Theory of Computation
G	Mathematics of Computing
H	Information Systems
I	Computing Methodologies
J	Computer Applications
K	Computing Milieux

Table 1: Level One of the ACM CCS.

H.0	General
H.1	Models and Principles
H.2	Database Management
H.3	Information Storage and Retrieval
H.4	Information Systems Applications
H.5	Information Interfaces and Presentation (e.g., HCI)
H.m	Miscellaneous

Table 2: Level Two of the ACM CCS Category H

H.3.0	General
H.3.1	Content Analysis and Indexing
H.3.2	Information Storage
H.3.3	Information Search and Retrieval
H.3.4	Systems and Software
H.3.5	Online Information Services
H.3.6	Library Automation
H.3.7	Digital Libraries
H.3.m	Miscellaneous

Table 3: Level Three of the ACM CCS Sub-category H.3

Abstracting methods
Dictionaries
Indexing methods
Linguistic processing
Thesauruses

Table 4: Un-encoded subject terms for Sub-category H.3.1

The original intention of the Classification Update Committee was that the level four terms would change frequently, as the domain of the categorisation system developed and changed. As deleting terms would have resulted in items categorised using these terms becoming invisible to searches, a decision was made to retain the terms in the CCS, but mark them to indicate that they are no longer to be used to categorise new items. The issue of the long term applicability of categories has posed significant problems for the Classification Update Committee. In 1998 they considered a major restructure of the scheme, but decided against it. The issue of a major redesign of the CCS remains on their agenda.

The IEEE has, with the permission of the ACM, devised an extended version of the CCS (IEEE, 2002). The changes range from apparently semantic eg D.2.8 under the ACM scheme is *Metrics* and under the IEEE scheme is *Metrics/Measurement*, to changes which represent a divergence of the two schemes eg under the ACM scheme, C.2.5 is *Local and Wide-Area Networks*, but under the IEEE scheme there are two categories C.2.5 *Local-Area Networks* and C.2.7 *Wide-area Networks.* With the independent development of both schemes, this divergence will most likely increase.

The MISQ Keyword Classification Scheme

The MISQ Keyword Classification Scheme was originally proposed in 1988 (Barki et al, 1988) and subsequently revised in 1993 (Barki et al, 1993).

The authors were aware of the CCS when they constructed the MISQ scheme, and it shows the influence of that scheme in its structure. Like the CCS, it is a tree based categorisation scheme. The scheme uses two alphabetic characters followed by two numeric categories, with the option of a further numeric category following a decimal point. It does not have explicit *general* or *miscellaneous* categories, or any general terms applicable as modifiers over any category. Unlike the CCS, it does have top level categories covering issues outside the explicit subject domain of information systems such as “Reference Disciplines” and the “External Environment”.

A web site providing access to the codes is available (MISQ, 2001). Disappointingly, no guidance is given in the use of the scheme, in the way that the ACM (ACM, 1998c) provides. Applying the ACM guidelines on the form of presentation of the keywords to the MISQ categories, a possible categorization of this paper would be: AI0106 [Research Methodology] Exploratory study; HA0902 [Types of Information Systems] Information search and retrieval

Tables 5 through 8 show the four levels of the MISQ scheme used to arrive at that categorisation.

There is no doubt that Barki and his collaborators have invested a large amount of work in producing the first scheme of some 1,100 keywords, and in the expansion of that to 1,300 keywords in the 1993 revision. Ten terms were deleted from the 1988 list. No discussion of the implication of these deletions for use or searching of the keyword terms occurs in their paper. As a result, category EC refers to "Administration of Computer Centres" in the 1988 scheme and to "Hardware Resource Management" in the 1993 scheme.

Given the lack of uptake of this scheme ten years after its last revision, it is somewhat ironic to read their comment:

> "As experience with the [CCS] scheme has shown, revision and maintenance are of utmost importance if the scheme is to remain useful and usable." (Barki et al, 1988, p300)

They go on to quote Foskett (1977):

> "those schemes which have relied on the genius of their compilers without the backing of an adequate organization, have gradually fallen into obsolescence, whereas those schemes which have adequate backing continue to progress" (p196)

A	Reference Disciplines
B	External Environment
C	Information Technology
D	Organizational Environment
E	IS Management
F	IS Development and Operations
G	IS Usage
H	Information Systems
I	IS Education and Research

Table 5: Level One of the MISQ scheme

AA	Behavioral Science
AB	Computer Science
AC	Decision Theory
AD	Information Theory
AE	Organizational Theory
AF	Management Theory
AG	Language Theories
AH	Systems Theory
AI	Research
AJ	Social Science
AK	Management Science
AL	Artificial Intelligence
AM	Economic Theory
AN	Ergonomics
AO	Political Science
AP	Psychology

Table 6: Level Two of the MISQ Category A

AI01	Research Methodology
AI02	Research Frameworks
AI03	Research Issues
AI04	Measurement
AI05	Diffusion Of Research
AI06	Statistical Methods
AI07	Research Models
AI08	Epistemology

Table 7: Level Three of the MISQ Sub-category AI

AI0101	Action research
AI0102	Case study
AI0103	Comparative study
AI0104	Empirical research
AI0105	Experimental research
AI0106	Exploratory study
AI0107	Conceptual study
AI0108	Field study
AI0109	Protocol analysis
AI0110	Laboratory study
AI0111	Literature review
AI0112	Ethnography
AI0113	Longitudinal study
AI0114	Meta-analysis
AI0115	Discourse analysis
AI0116	Hermeneutics
AI0117	Quasi-experimental study
AI0118	Secondary data analysis
AI0119	Citation analysis

Table 8: Level Four of the MISQ Sub-category AI01

The development approaches for the ACM and MISQ schemes

The ACM CCS Update Committee is chaired by Neal Coulter and has thirteen members. The current version of the CCS is the fourth revision. The CCS Update Committee conducted a major review of the CCS in 1998 (ACM 1998b). The review was funded by the ACM SIG Discretionary Fund and by the ACM Publications Board. Its charter was:

- Review the structure, content, and utility of the Computing Classification System.
- Recommend changes in the CCS as required to keep the taxonomy current, while still preserving the historical value of the CCS in searching previously classified literature.
- Investigate the feasibility of having CCS supporting materials. An online dictionary of CCS terms might be especially useful.
- Investigate the utility of electronic access to the CCS and its supporting materials.
- Determine a mechanism for more streamlined and rapid CCS revisions.

The CCS Update Committee proposed that indexing terms would be suggested from four main sources:

- Indexers
- A list of free-text words derived from the literature
- *ACM Computing Reviews* editors
- The general public

The report also recognised that a more thorough redevelopment of the CCS was necessary and made a number of recommendations in this regard:

1. "Perform a more careful and conclusive analysis of the current CCS's strengths and weaknesses. (What are its goals, and how does it meet these goals?) This analysis would include an evaluation of the range of documents that are now indexed in the *ACM Guide to Computing Literature* to ensure that it is widely representative of the field of computing. Also, this analysis should be done by a team of experts representing all subfields of computing, including—in particular—representatives from the IEEE Computer Society.
2. Study other bibliographic database systems, including their indexing schemes, methodologies for keeping their taxonomies current, software support, and other tools (dictionaries) for database maintenance and searching.
3. Consider the development of an online dictionary or thesaurus for the CCS that would interact with the new taxonomy and assist users and indexers who work with the database. Such a dictionary would provide not only definitions of terms but also important information about synonymy (related terms) and semantic hierarchy (broader terms and narrower terms).
4. Design a new classification system, using a variety of contemporary sources (including the current CCS and the documents mentioned above) that might more accurately reflect the modern structure of the field and its published literature.
5. Use statistical content analysis methods to corroborate/refine this new taxonomy, using a significantly large corpus of text from the current and recently published literature.
6. Suggest a mapping function that preserves the historical integrity of the current database and CCS taxonomy in future searching and indexing activities. It should connect the terms in the new taxonomy both with the terms in the current taxonomy and with the terms in the online dictionary.
7. Estimate the cost and timeline for accomplishing a conversion of the current CCS to a new system that would have the above characteristics." (ACM, 1998b, 4)

The MISQ scheme was developed by three researchers from the École des Hautes Études Commerciales in Montréal: Henri Barki, Suzanne Rivard, and Jean Talbot. Their starting point was a research framework by Ives et al (1980), which was chosen on the basis of perceived completeness and its, then, recent publication. The research framework had been validated by examining the research areas of 331 MIS doctoral dissertations written between 1973 and 1979, which had been located using the *Comprehensive Dissertations Index* which, Ives et al note, contains between 80% to 95% of recent USA dissertations, but does not include many European or Canadian dissertations.

A list of some 2,000 keywords was then compiled from:

- All issues of *MIS Quarterly*

- *Information & Management* since 1977
- Information systems papers published in *Communications of the ACM*
- *Management Science* since 1978
- *Decision Science* since 1980

The authors of the MISQ scheme then debated the need for and the place of particular keywords within the framework. As a result of this process, the Ives et al framework was modified into the top level categories of the 1988 scheme, and the detailed structure was determined. The categorisation scheme was then tested by circulation of a questionnaire to information systems researchers in Canada and the USA.

The 1993 revision of the MISQ scheme was undertaken by examining articles published in:

- *MIS Quarterly*
- *Journal of MIS*
- *Information & Management*
- Information systems articles published in *Management Science*
- Information systems articles published in *Communications of the ACM*
- *Information Systems Research*
- *Organization Science*

New keywords were added to the scheme after a consensus of the authors had been reached on whether and where a keyword should be added.

PROPOSED RESEARCH APPROACH

In examining the existing categorisation schemes or developing new schemes, there are two main dimensions that need to be considered:

- Are the categorisation schemes complete, that is to what degree can any item of information systems research be precisely allocated to one or more categories?
- What mechanisms exist to ensure the use and continued relevance of the categorisation scheme?

In looking at these questions three reference disciplines immediately suggest themselves: librarianship and information science; sociology; and philosophy.

Librarianship and Information Science

Librarians have been concerned with the question of locating and obtaining information required by end users for many years. The basic problem is often expressed by them using set theory. If we consider the set of all documents over which we wish to run a search, L, the subset of documents which we are searching for to be A ($A \subseteq L$), and the subset of documents actually returned to be B ($B \subseteq L$), then the relevant documents will be the subset forming the intersection of A and B ($A \cap B$). From this they define two measures (Foskett, 1977):

$$\text{Recall ratio} = \frac{|A \cap B|}{|A|} \text{ ie } \frac{(\textit{relevant documents retrieved})}{(\textit{total of relevant documents})}$$

$$\text{Precision ratio} = \frac{|A \cap B|}{|B|} \text{ ie } \frac{(\textit{relevant documents retrieved})}{(\textit{total of documents retrieved})}$$

Categorisation schemes are seen as one mechanism to attempt to increase the number of relevant documents retrieved, and minimise the number of irrelevant documents retrieved. In particular, librarians talk of *specificity*: the extent to which the system permits us to be precise when specifying the subject of a document being processed. A high degree of specificity should increase the number of relevant documents returned, low specificity will result in high recall, but low precision. As an example, if we desire to search for documents concerning “relational databases”, but the system only allows us to specify “databases”, then a large number of documents will be returned concerning databases other than relational databases. Nothing can be done at the search stage to increase specificity.

Librarians call the assignment of terms for indexing of documents at the time of creation or storage, as opposed to the time of searching, *pre-coordinate* indexing. They distinguish between two major issues in assigning index terms: *semantics* and *syntax*. (Foskett, 1977)

One of the key activities in the area of semantics is the choice of the terms to be used, otherwise known as concept indexing. Five major classes of indexing terms are recognised:

Entities	things which may be given a denotative meaning, ie we can point at them
Activities	usually denoted by verbal nouns
Abstracts	usually refer to qualities or states
Properties	may be either subjective (dull, shiny, loud) or related to mechanical properties (loose, rigid)
Heterogenous	represent concepts which might be further analysed into two or more simpler concepts that would fit into the above categories, but are generally regarded as unitary concepts and treated as such. (demography, roles of people)

Table 9: Semantic classes of indexing terms (after Foskett,1977)

The area of syntax examines the way in which terms relate. In particular, issues such as the way terms might be ordered or considered superior or subordinate are considered. Quite a number of ways of determining these issues have been examined. These range from the development of artificial indexing languages, through schemes which use permutations of terms to cover as many search approaches as possible, to the probabilistic analysis of users' search strategies.

Sociology

Rosch (1978) provided a seminal work on the question of explaining categories found in a culture, and coded by the language of that culture. She proposed two fundamental principles for the formation of categories: *cognitive economy* and *perceived world structure*. The principle of cognitive economy is that categorisation should provide a great deal of information about the item categorised with minimal resources expended. To categorise an item means to consider it, for the purposes of the categorisation, as equivalent to other items in the same category and different from items not in that category. The principle of perceived world structure states that in the perceived world, there is a high correlational structure. For example, the conceptual segmentation of a bird's body so that we identify "wings", may be influenced not only by perceptual factors, such as an understanding of form, but also by the fact that we already have a cultural and linguistic category called "birds". The world is not an "unstructured total set of equiprobable co-occurring attributes" (Rosch, 1978).

Rosch distinguished between horizontal and vertical dimensions of categories. Her starting point was what she termed *basic level objects*. If you consider "chair" as a basic level object, "furniture" would be considered *superordinate* and "kitchen chair" as *subordinate* in the vertical dimension. Distinguishing between objects in the horizontal dimension poses difficulties of where boundaries should be placed. Rosch deals with this by focussing on prototypes – the clearest cases of category membership. This was based on research by her and others over a number of years which found that subjects could "overwhelmingly agree in their judgements of how good an example or clear a case members are of a category, even for categories about whose boundaries they disagree" (Rosch, 1978).

Philosophy

Within the domain of philosophy, ontology has been used to study types of entities in reality, the objects, properties, categories and relations that make up the world. Ontology is a part of metaphysics that has been discussed since the time of Aristotle. Artificial intelligence (AI) researchers have a particular view of ontology, referring to it as "an engineering artifact, constituted by a specific vocabulary used to describe a certain reality, plus a set of explicit assumptions regarding the intended meaning of the vocabulary words" (Guarino, 1998) A far more general definition is "the science of being in general, embracing such issues as the nature of existence and the categorical structure of reality. … Different systems of ontology propose alternative categorical schemes. A categorical scheme typically exhibits a hierarchical structure, with 'being' or 'entity' as the topmost category, embracing everything that exists" (Honderich, 1995). This latter approach to the definition and use of ontology has also been successfully used in information systems, for example in comparing and evaluating data modelling frameworks (Milton, 2000).

Issue 5-6 of volume 43 of the *International Journal of Human-Computer Studies* contains a selection of papers developed from the *International Workshop on Formal Ontology in Conceptual Analysis and Knowledge Representation* held in 1993, including two papers (Guarino, 1995 and Smith, 1995) which survey this field from the points of view of the alternative definitions given above. Smith (1995) focuses on natural cognitive systems as distinct from the cognitive activities of, for example, mathematicians or ufologists that rely on ontologically peculiar worlds. One of the concepts discussed by Smith is the approach of Franz Brentano to mereology. Mereology concerns the basic organising relationships of part to whole, part to part within a single whole, of identity, overlapping and discreteness. Brentano explores the relations among parts of a single whole. One of the concepts he identifies is where parts cannot exist except in association with their complementary parts in a whole of a given type. There is an echo of the heterogenous class identified by Foskett (1977) in Table 9 in this approach.

Ontological studies have been methodologically based on introspection and analysis of world models and abstract theories. Smith and Mark (1999) have reported on an experiment in the use of empirical methods to test aspects of an ontological theory of geographic objects. Their work is of particular relevance to this study, as the work of Rosch (1978) on basic level categorisation and its application by later researchers to geographic objects was a source for the experimental methods.

Reent work around the Semantic Web and the IEEE Standard Upper Ontology (IEEE, 2003), DOLCE (Gangemi et al, 2002), and BFO (Grenon, in preparation) is encouraging with respect to our research objectives in that they all recognise the central role of reference ontologies in information systems, specifically information categorisation. The applicability of these approaches will have to be considered.

CONCLUSIONS

There is a distinct lack of adoption of common keyword systems for subject indexing in information systems research publications. *Prima facie* the existing schemes are not meeting the needs of their intended users. Either the schemes themselves are not useful, they are cumbersome, difficult or obscure to use, or some other impediment is preventing their uptake.

The maintenance of the schemes is problematic. The ACM CCS and the IEEE ECCS are maintained independently of each other and are beginning to diverge. The MISQ scheme was developed by three information systems researchers, and no update has appeared since 1993. These schemes appear to have been developed by empirical analysis of the keywords used or requested by researchers in the subject domains of the particular categorisation scheme. The identified keywords are then fitted into the scheme. There is little or no evidence of any overarching conceptual framework or ontology giving structure to any of the schemes.

A fundamental assumption in this paper is that the categorisation schemes mentioned are one dimensional, that is that they are attempting to categorise one aspect of information systems research – its subject domain. However, this is not explicitly stated anywhere in the documentation of the schemes. The MISQ categorisation proposed for this paper includes AI0106 indicating that the paper is an exploratory study. But is this a correct use of the MISQ scheme? If the intent of the scheme is to code only the subject domain, then an AI0106 categorisation would be interpreted that the subject of this paper is the use of exploratory studies on information search and retrieval systems, rather than an exploratory study of information search and retrieval systems. Such ambiguity does not assist in either allocation of, or searching on the categories defined by the schemes.

Beyond the question of the subject categorisation of information systems research lies the matter of eliciting other significant dimensions by which information systems journals should be categorised and determining schemes for those dimensions. It should be noted that there are a number of studies of the categorisation of information systems research using other frameworks. Walstrom and Hargrave (2001) looked at rating information systems journals according to what they termed pure or hybrid journals. Holsapple et al (1994) proposed a hierarchical categorisation of information systems journals, differentiating between academic and practitioner oriented journals. Walczak (1999) looked at ranking information systems journals across research disciplines and the earlier works of Ives et al (1980) and Hurt et al (1986) are also significant. While these studies are beyond the scope of this paper, their investigation should inform future research into this area.

Several research disciplines have been identified in this paper with a considerable body of knowledge and practice in the area of categorising and determining the completeness and effectiveness of particular categorisation schemes. These could be used to guide the development of a multi-dimensional categorisation scheme for information systems research activities, and for the categorisation of publications accepting papers on information systems research activities.

Our premise is that the long term visibility of information systems research output is important to individuals who want to know about such research and to be known for such research. Existing schemes appear to be unworkable and are not widely used in information systems research journals. The schemes reviewed lack a coherent framework and the methodologies for their development are pragmatic and not driven by relevant theory. In this paper we have reviewed three bodies of relevant theories that could address this limitation. We propose to address the research questions raised in this paper by examining in detail the three bodies mentioned and undertake further research using the most promising theoretical basis.

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