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Fang-Ming Hsu National Dong Hwa University, fmhsu@mail.ndhu.edu.tw

Chun-Min Lin National Dong Hwa University, d9832012@ems.ndhu.edu.tw

Chiu-Tsu Fang Department of Business Administration, Tungnan University, Taiwan, R.O.C., jofan@mail.tnu.edu.tw

Chu-Mei Chiu National Dong Hwa University, cmchiu@archives.gov.tw

Pei-Hsin Chen National Dong Hwa University, gina90410@gmail.com

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THE INTELLECTUAL STRUCTURE OF ELECTRONIC RECORDS MANAGEMENT

- Fang-Ming Hsu, Department of Information Management, National Dong Hwa University, Taiwan, R.O.C., fmhsu@mail.ndhu.edu.tw
- Chun-Min Lin, Center of General Education, Taiwan Hospitality and Tourism College, and Department of Information Management, National Dong Hwa University, Taiwan, R.O.C., d9832012@ems.ndhu.edu.tw
- Chiu-Tsu Fang, Department of Business Administration, Tungnan University, Taiwan, R.O.C., jofan@mail.tnu.edu.tw
- Chu-Mei Chiu, Archival Information Systems Division, National Archives Administration, and Department of Information Management, National Dong Hwa University, Taiwan, R.O.C., cmchiu@archives.gov.tw
- Pei-Hsin Chen, Department of Information Management, National Dong Hwa University, Taiwan, R.O.C., gina90410@gmail.com

Abstract

A number of countries have launched projects with a particular emphasis on using information technologies (IT) to provide electronic information and services to citizens and businesses. Through various IT, tremendous amount of electronic records in government agencies are created. These records and archives are the basis of knowledge management. Electronic records management (ERM) is a fast growing field throughout the last decades. Theoretical foundations for ERM have remained obscure from the research community.

To map the intellectual structure of ERM research, this study identifies the high-impact articles as well as the correlations among these scholar publications. In this study, co-citation, co-word, association rule and cluster analysis techniques are used to investigate the intellectual pillars of the ERM literature. This study exposes researchers to a new way of profiling knowledge networks and their relationships the area of ERM, thereby helping academia and practitioners better understand contemporary studies. The results of the mapping can help identify the research direction of ERM research, provide a valuable tool for researchers to access ERM literature, and acts as an exemplary model for future researches.

Keywords: Electronic Records Management, Intellectual Structure, Co-word, Co-citation Analysis

1 INTRODUCTION

More records of human activity have been generated in last decade than any previous decade. Several trends are emerging in the management of records and archives, including a shift from paper-based storage to computer-based systems, from managing information to supporting its access and retrieval, and from cost-reduction to continued process improvement (Stephens, 1998). These trends all highlight the need for electronic records management (ERM) in the operation of digitizing records and archives.

Document is an important form of implicit knowledge. In the era of information technology (IT), electronic records are critical to knowledge management and digital humanity. Government agencies often organize their services and operations into programs that may be changed in response to a host of factors, including IT implementations (Walker, 2001). After the promotion of electronic government in Taiwan, tremendous records are created and preserved by government agencies through their documents and records management system, especially in online signature system. Through various IT and media, past activities of government are preserved as critical memory in agencies after filing. Records management (RM) is defined as the systematic and administrative control of records throughout their life cycle to ensure efficiency and economy in their creation, use, handling, control, maintenance, and disposition (Kettunen and Henttonen, 2010). Since 2001, international standards for records management, ISO 15489, are promulgated by International Organization for Standardization (ISO) to advocate related rules for their management. Agencies should preserve records carefully to protect the authenticity, reliability, integrity, and usability of records for long-term usage.

Electronic records and archives, whether born digitally or digitized from paper, are documented by information systems. Traditionally, records and archives management include all aspects of archival science – as more traditionally understood through the life cycle model, as well as all aspects of the creation, preservation, use, and disposition of records that are delineated in the records continuum model. The concept of RM research is similarly broadly construed and also includes research on archival and recordkeeping topics being undertaken by researchers (Gilliland-Swetland and McKemmish, 2004). Many issues are blooming in this field such as authenticity, digital signature, migration, encapsulation, digital certification and social network. For better preservation and management of records, agencies start to cooperate with information systems vendors to meet the regulation of rules. These alliance activities have dependencies in the sense that the completion of each RM operations influence the others, and these dependencies need to be managed.

Since 1990, the development of RM and archival research consciousness has unprecedented growth in the academy and in practice, as well as in scholarly awareness that the construct of the archives, and recordkeeping more generally, provides a rich locus for research and theorizing (Gilliland-Swetland and McKemmish, 2004). This tendency raises questions regarding what are important when their activities are not well known, what does IT consist of, and what is the focus of this management exercise. Research in records management is unique insofar as it takes place within a multidisciplinary environment encompassing history, management, computer science, and library science (Couture and Doucharme, 2005). Although ERM is becoming increasingly common in this information age, our understanding of their operation and management does not reflect their expanding role in organizations. The intellectual structure of ERM regarding technology, management and social behavior has been limited understanding. The objective of this study is to investigate the intellectual structure of ERM among milieu factors of practice, concept, technology and management.

2 LITERATURE REVIEW

The literature on information technology, systems development, records management, and digital archives provides the theoretical basis for ERM. Since the 1990s, electronic records and digital

archives have advanced tremendously – not only in terms of the scope of technology it encompasses, but also in the development of its knowledge (Gilliland-Swetland and McKemmish, 2004).

2.1 Related Research on Electronic Records Management

A number of prior studies have reflected on records/archives management as an academic discipline. Assessment of ERM as a field, from both an historical and a forward-looking perspective, served as one important theme for record/archive management. Cox (1987) examined academic journals, monographs, yearbooks etc. related to archival studies, library and information science, and history from 1901 to 1987. Cox classified RM and archival literature into 10 categories: arrangement and description; history, organization, and activities of repositories; management of current records; general literature; preservation, restoration, and storage; application of photographic processes; appraisal and disposition; training and professional development; special physical types of records and manuscripts; and historical editing and documentary publication. Cox and Samuels (1988) argued that typology of research fields in ERM included: 1. Developing broader education and practical training in the management of electronic records, 2. Employer needs in the management of electronic records management programs in organizations, 5. Archivists' attitudes towards technology, 6. Archival profession and technology.

Academic disciplines typically seek to articulate the intellectual structures upon which they can cultivate their futures (Hirschheim, Klein and Lyytinen, 1996). Hedstrom (1991) argued that typology of research fields in ERM included: 1. Which relationships can be established among functions, activities, organizational structures, and information systems? 2. What new kinds of records are generated by information technologies? 3. Can archivists intervene at the critical moment when new technologies are developed and introduced in an organization? 4. How can electronic records influence archival practices in information preservation and accessibility? 5. How do the requirements of the management of electronic records alter the archival profession? Bearman and Trant (1998) argued that typology of research fields in ERM included: 1. Description of an electronic record, 2. Electronic records management policy, 3. Recognizing record-creating events, 4. Dependency among hardware, software, metadata, and organizational structures, 5. Maintaining electronic records over time, 6. User needs and the retrieval of electronic information.

Couture and Doucharme (2005) argued that typology of research fields in archival science included: 1. The object and aim of archival science, 2. Archives and society, 3. The history of archives and of archival science, 4. Archival functions, 5. The management of archival programs and services, 6. Technology, 7. Types of media and archives: electronic records, 8. Archival environments, 9. Specific issues related to archives. Kim and Lee (2008) collected articles of archival science from 2001 to 2004, generated pathfinder networks of 43 clusters and grouped them into seven subject categories: digital libraries and digital archiving technologies, online resources and finding aids, archives and archivists, legal and political issues, electronic records and technical issues, records and information management, and e-mail and information professionals. Finally, these seven subject categories were merged into three sectors: digital library, archives and management. This study describes dynamic change in the 2001–4 research themes from traditional single-subject areas to emerging, complex subject areas.

Given the increased importance of electronic records in the American archival context, the National Historical Publications and Records Commission (NHPRC) established a Working Group on the Management of Electronic Archival Information (WGMEAI) with the mandate to elaborate a program framework encourage research in the field of electronic records management. From holistic view, National Historical Publications and Records Commission (NHPRC, 1991) in USA argued that typology of the national research program in ERM included: 1. Identifying the functions and data necessary for the management of electronic records, 2. Technical, conceptual, and economic implications of the creation and preservation of data as well as the related information elements for their context and description, in electronic formats, in various applications, 3. Preservation of software-dependent data objects for future use, 4. Use of information system metadata to support

electronic records management and archival requirements, 5. Archival requirements are integrated into the development of information systems, 6. Electronic records management policy, 7. Developing an electronic records management program, 8. Incentives that can contribute to creator and user support for electronic records management concerns, 9. Barriers to the implementation of an electronic archival records management program, 10. Archivists' knowledge of technology and electronic records.

ISO 15489 has raised the risk of records management as authenticity, reliability, integrity, and usability of records for long-term usage. Unsuitable management will lead to the loss of evidence of agencies' activities. Records management procedures and practices should lead to authoritative records which have the characteristics given in authenticity, reliability, integrity and usability (ISO, 2001). An authentic record is one that can be proven to be what it purports to be, to have been created or sent by the person purported to have created or sent it, and to have been created or sent at the time purported. To ensure the authenticity of records, organizations should implement and document policies and procedures which control the creation, receipt, transmission, maintenance and disposition of records to ensure that records creators are authorized and identified and that records are protected against unauthorized addition, deletion, alteration, use and concealment.

A reliable record is one whose contents can be trusted as a full and accurate representation of the transactions, activities or facts to which they attest and can be depended upon in the course of subsequent transactions or activities. Records should be created at the time of the transaction or incident to which they relate, or soon afterwards, by individuals who have direct knowledge of the facts or by instruments routinely used within the business to conduct the transaction. The integrity of a record refers to its being complete and unaltered. It is necessary that a record be protected against unauthorized alteration. Records management policies and procedures should specify what additions or annotations may be made to a record after it is created, under what circumstances additions or annotations may be authorized, and who is authorized to make them. Any authorized annotation, addition or deletion to a record should be explicitly indicated and traceable.

An useable record is one that can be located, retrieved, presented and interpreted. It should be capable of subsequent presentation as directly connected to the business activity or transaction that produced it. The contextual linkages of records should carry the information needed for an understanding of the transactions that created and used them. It should be possible to identify a record within the context of broader business activities and functions. The links between records that document a sequence of activities should be maintained.

Electronic records can be conceptualized as a package of standards. It builds on existing technical standards (e.g., with respect to operating systems, databases, and network standards). It embeds procedural and performance standards as well as numerous classification schemes and terminologies (Hanseth, Jacucci, Grisot and Aanestad, 2006). Therefore, we can conclude that there are at least two-fold dimensions of ER management, i.e. technology-management and practice-concept perspective, as depicted in Figure 1.



Figure 1. Two-fold dimensions of management in electronic records

The field of ERM has grown by relying on the intellectual structures provided in the classic document management works. This study reconsiders the basis on which the field de facto has been structured.

In so doing, it is our hope that a conceptual foundation for future theories in the domain of ERM may be possible.

2.2 Prior Research on Intellectual Structure and Bibliometric Method

Bibliometric methods have been successfully applied to examine the intellectual structure of several disciplines (White and McCain, 1998). Bibliometrics is a research method commonly used in library and information science. It uses quantitative analysis and statistics to depict patterns of publication within a given field or body of literature. Researchers may use bibliometrics to determine the influence of an article, for example, to describe the relationship between the given article and the other articles. Co-citation analysis is based on the hypothesis that articles cite papers they consider to be important to the development of their research. Chandy and Williams (1994) pointed out that citations are viewed as the explicit linkages between articles that have common aspects. Cronin (1984) described the citation process as a detailed theoretical scrutiny that includes a review of the role and the content of citations. Within all academic disciplines, researchers typically cluster articles into informal networks that focus on common questions in common ways, and within these networks, one scholar's concepts and results may be picked up by another, to be extended, tested, and refined. Therefore, the history of the exchanges between members of these networks, revealed in patterns of citations, describes the intellectual structure of a field. When one scholar cites prior work of another, citation analysis provides a means of documenting this process. Co-citation analysis reflects many papers that have cited any particular pair of documents and it is explained as a measure of similarity of content of the two documents.

Co-citation analysis is a well-practiced technique and frequent mappings have shown us that the relationship between co-cited articles is normally "intellectual," based on research area subject themes (Zuccala, 2006b). This approach is instrumental in identifying groupings of articles, topics, or methods and can help us understand the way in which how these clusters related to each other (Pilkington and Liston-Heyes, 1999). More specifically, co-citation studies compile co-citation counts in matrix form and statistically scale them to capture a snapshot at a distinct point in time of what is actually a changing and evolving structure of knowledge (Zuccala, 2006a).

Co-citation analysis, which uses a matrix of co-citation frequencies between articles as its input, predicates that the conceptual similarity in the works of such articles will increase the likelihood of their being cited together regularly (McCain, 1990). Co-citation analysis is a bibliometrics technique that information scientists use to map the topical relatedness of clusters of articles, journals or articles, i.e. the intellectual structure of a research field (Zuccala, 2006b). Co-citation analysis uses articles as the units of analysis and the co-citations of pairs of articles as the variable that indicates their distances from each other. The underlying assumption of co-citation is that the more two articles are cited together, the closer the relationship between them (White and Griffith, 1981). The co-citation count for each pair of articles is acquired, after which the article co-citation analysis is performed. Co-citation analysis is one of the major tools commonly used and accepted in bibliometrics area for mapping the intellectual structure of a researched field. Co-citation studies use a matrix to store the aggregated co-citation counts statistically to grasp a snapshot at a distinct point in time of what is actually a changing and evolving structure of knowledge (Zuccala, 2006b).

Several studies have used this method to aid their researches, particularly in the management field. Acedo and Casillas (2005) identified the main research trends in the top international management journals between 1997 and 2000 also by means of co-citation analysis. Acedo, Barroso and Galan (2006) identified the main trends within the resource-based theory using co-citation analysis and futher noting their diffusion among the leading management-oriented journals. Zuccala (2006b) employed the co-citation analysis technique in her study on comparing ACA and another sister technique named Web co-link analysis. Our study applied co-citation analysis to gain insights to the research paradigms of ERM research field.

3 RESEARCH METHODOLOGY

The purpose of this study is to explore and map the intellectual structure of ERM studies during the period of 2001 to 2012. With bibliometric analysis, this study had four phases, each of which required different approaches to examine the evolution of the ERM studies. The databases of journals in library and archival science serve as the basis for the analysis and their extensive collection of references from refereed journals.

Researches regarding electronic records management exist in the publications of topics of electronic records and digital archives. Besides, the term "electronic" sometimes is synonym to "digital." Therefore, this study utilized the key-word search strategy which involved search for the keyword *Electronic Records, Digital Records, Electronic Archives*, and *Digital Archives* in related databases to identify the potential ERM articles. The data used in this study includes journals, publication titles, article names, publication dates, keywords and citation index. Journals with a high rank are considered to be core journals disseminating essential knowledge of a discipline. Articles in core journals are thus often regarded as important publications and are associated with higher frequency of citation. In addition, the references cited by core journal articles may make essential contribution to the development of a discipline because these articles evaluate and cite literature that is of high quality. The collected data were analyzed and systematized by sorting, summing, ranking and screening based on the total citation counts each received.

The next step is to perform the data collection and analysis based on the data set. The most frequently cited articles in each year time period were identified as the core articles in the field and further examined with co-citation analysis. The co-citation count for each pair of articles is retrieved and the co-citation analysis is performed. The co-citation count represents the similarity of each pair of articles.

Besides, the most frequently used term in total time period were identified as the core terms in the field and further examined with co-word analysis. The co-word count for each pair of terms is retrieved through 2-items set of association rule method. The co-word count represents the similarity of each pair of terms. A series of operations are conducted, through which it is possible to identify the intellectual structure of ERM studies (Pilkington and Teichert, 2006).

Cluster analysis is also commonly used program to map the intellectual structure of studies and determine the common links between articles (Tu, 2012). The last step of cluster analysis is performed to group these articles according to the similarity of their research themes and focuses. By taking the co-citation matrix and grouping the articles using cluster analysis of the correlations between the entries, this study can determine which articles are grouped together as well as their common shared elements. The closeness of article points on these maps is algorithmically related to their similarity as perceived by citers.

Australian Research Council has announced a report regarding the rank of journal (Haslam and Koval, 2010). They are ranked as follows: A* (top 5%): "Virtually all papers they publish will be of a very high quality"; A (next 15%): "The majority of papers in a Tier A journal will be of very high quality"; B (next 30%): "Generally, in a Tier B journal, one would expect only a few papers of very high quality"; and C (next 50%): Journals "that do not meet the criteria of higher tiers." This study uses journals ranked with A*, A, and B and in the field of Library and Information Studies as target. 48 journals and 344 articles are selected in the duration from 2001 to 2012. Selected journals and amount of ERM related articles are described in Table 1.

Title and keywords reflect the key concept of articles. This study extracts key terms to cluster the articles. Whereas the works of previous studies drew their inspiration largely from co-citation, we draw on co-citation, co-word and cluster analysis to explore the intellectual structures of ERM.

| No | Journal | Amount of Selected Articles |
|----|---|--------------------------------|
| 1 | Records Management Journal | 39 |
| 2 | The American Archivist | 33 |
| 3 | Archival Science | 24 |
| 4 | International Journal of Digital Curation | 22 |
| 5 | Journal of Archival Organization | 22 |
| 6 | Journal of the Society of Archivists | 19 |
| 7 | The Electronic Library | 17 |
| 8 | Program: Electronic Library and Information Systems | 14 |
| 9 | D-Lib Magazine | 12 |
| 10 | Government Information Ouarterly | 10 |
| 11 | International Journal on Digital Libraries | 10 |
| 12 | Journal of Digital Information | 10 |
| 13 | Library Trends | 10 |
| 14 | Journal of Library Administration | 9 |
| 15 | Library Hi Tech | 9 |
| 16 | Online Information Review | 7 |
| 17 | DESIDOC Journal of Library & Information Technology | 6 |
| 17 | OCL C Systems & Services: International digital library perspectives | 6 |
| 10 | Archival Issues | 5 |
| 20 | Journal of Documentation | 5 |
| 20 | Vino | 5 |
| 21 | Ville | 3 |
| 22 | Library Collections, Acquisitions, and Technical Services | 4 |
| 23 | Library Collections, Acquisitions, and Technical Services | 4 |
| 24 | Library Resources and Technical Services | 4 |
| 25 | Interlending & Document Supply | 3 |
| 26 | Malaysian Journal of Library & Information Science | 3 |
| 27 | Reference & User Services Quarterly | 3 |
| 28 | Evidence Based Library and Information Practice | 2 |
| 29 | International Journal of Information Management | 2 |
| 30 | Journal of Education for Library and Information Science | 2 |
| 31 | Journal of Information Science | 2 |
| 32 | Library Review | 2 |
| 33 | Libres | 2 |
| 34 | New Review of Hypermedia & Multimedia | 2 |
| 35 | Reference Services Review | 2 |
| 36 | Archives and Manuscripts | 1 |
| 37 | Aslib Proceedings | 1 |
| 38 | Artificial Intelligence and Law | 1 |
| 39 | Collection Building | 1 |
| 40 | Information Development | 1 |
| 41 | Information Technology and Libraries | 1 |
| 42 | Journal of Interlibrary Loan, Document Delivery & Electronic Reserves | 1 |
| 43 | Library & Information Science Research | 1 |
| 44 | Library Management | 1 |
| 45 | Library Quarterly | 1 |
| 46 | Multimedia Tools and Applications | 1 |
| 47 | New Library World | 1 |
| 48 | Portal: Libraries and the Academy | 1 |

Table 1.Selected journals and amount of related articles

4 RESEACH RESULTS AND FINDINGS

4.1 Co-citation Analysis

This study used Google Scholar to retrieve the citation of each article. The articles with high citation are collected as described in table 2.

| Article No | Title of Article | Year | Journal | Citated Amount |
|---------------|--|------|---|-------------------|
| 1 | DSpace: An open source dynamic digital repository | 2003 | D-Lib Magazine | 220 |
| 2 | Towards user-centered indexing in digital image collections | 2006 | OCLC Systems & Services | 69 |
| 3 | Fluid ontologies for digital museums | 2005 | International Journal on Digital Libraries | 54 |
| 4 | Assessing information on the Internet: Toward providing library services for computer-mediated communication | 2001 | Journal of Library Administration | 49 |
| 5 | The concept of record in interactive, experiential and dynamic environments: The view of InterPARES | 2006 | Archival Science | 48 |
| 6 | Counting the costs of digital preservation: Is repository storage affordable? | 2004 | Journal of Digital Information | 44 |
| 7 | Building preservation environments with data grid technology | 2006 | The American Archivist | 32 |
| 8 | The benefits of electronic records management systems: A general review of published and some unpublished cases | 2005 | Records Management Journal | 32 |
| 9 | The power of meaning: The archival mission in the postmodern age | 2002 | The American Archivist | 31 |
| 10 | Participatory archive: towards decentralised curation, radical user orientation, and broader contextualisation of records management | 2008 | Archival Science | 28 |
| 11 | Oral history in the archives: Its documentary role in the twenty-first century | 2003 | The American Archivist | 29 |
| 12 | Digital preservation theory and application: Transcontinental persistent archives testbed activity | 2007 | The International Journal of Digital Curation | 29 |
| 13 | E-government and records management: an assessment tool for e-records readiness in government | 2007 | The Electronic Library | 27 |
| 14 | Access to government information in Japan: a long way toward electronic government? | 2003 | Government Information Quarterly | 28 |
| 15 | Create once, use many times: The clever use of recordkeeping metadata for multiple archival purposes | 2005 | Archival Science | 26 |
| 16 | The open achives initiative: Realizing simple and effective digital library interoperability | 2001 | Journal of Library Administration | 26 |

| Table 2. | Title, | year, | journal | and | citation | amount | of | selected | articles |
|----------|--------|-------|---------|-----|----------|--------|------|----------|----------|
| | , | 2 | | | | | · ./ | | |

The co-citation amounts of two articles are counted for co-citation matrix of selected articles. This cocitation matrix is then used as the correlation input for hierarchical cluster analysis with Ward's method to evaluate the relationship of articles. These 16 selected articles can be aggregated into seven clusters. The result of hierarchical cluster is depicted in Figure 2.



Figure 2. Hierarchical cluster of selected articles from co-citation analysis

Seven clusters of selected articles are described as follows:

1. Digital Preservation

Cluster 1 includes the article 6 and 12 with the topic regarding digital preservation. Theory, application, infrastructure and cost of digital preservation are discussed in these two articles. Archival quality are most closely associated through the preservation management of digital surrogates (Conway, 2011). Digital preservation is the center of ERM research.

2. Digital Repository

Cluster 2 includes the article 1, 7 and 11 with the topic regarding digital repository. Digital repository, data grid technology and cultural heritage are discussed in these three articles. A trusted digital repository (TDR) is a set of metrics that are used to certify that a given repository is an appropriate custodian of a collection of digital assets. More than an array of abstract measures, however, a TDR represents a stable and sustainable organization, a set of policies and procedures for sound management of the digital objects, and a robust and secure technical platform (Johnston, 2012). Digital repository is an important part of ERM research.

3. Critical Projects

Cluster 3 includes the article 5 and 15 with the topic regarding critical ERM projects. The concept and clever usage of InterPARSE Project (International Research on Permanent Authentic Records in Electronic Systems Project) are discussed in these two articles. InterPARES is that such solutions are situation specific and must be devised by preservers in light of: (a) the cultural, legal, administrative, and functional context in which they operate; (b) the nature and characteristics of the organization or person producing the digital material; (c) the typology of the material produced and its documentary and technological features; (d) the limitations imposed by the available financial and human resources; (e) the organizational culture of both the producer of the material and the preserver itself (Külcü and Çakmak, 2010). Many projects are issued for ERM research.

4. Archiving

Cluster 4 includes the article 9 and 10 with the topic regarding archiving. Archival professional and participatory archive are discussed in these two articles. The archiving of items is not a mere copying process of bits and bytes from object to another but rather a transformation of a digital object that is made to fit the requirements of provenance and authenticity. This transformational process goes beyond the traditional practices of collection, documentation, and preservation, leading not merely to

a change of the context in which the object is embedded but to a change of the object itself (Kallinikos, Aaltonen, and Marton, 2013). Archiving is an important process for ERM.

5. Electronic Records Management

Cluster 5 includes the article 8 and 13 with the topic regarding electronic records management. Electronic records management systems, records management and electronic document delivery are discussed in these two articles. The primary contribution of diplomatics to an understanding of electronic records is its analysis of the attributes of a record based on concepts and principles that have evolved over centuries of detailed study of the documentary process (Duranti, 2001).

6. Metadata

Cluster 6 includes the article 2 and 16 with the topic regarding metadata. User-generated metadata and metadata exchange are discussed in these two articles. During the last 20 years, records managers and archivists have focused on defining requirements for functionality and metadata of electronic records management systems (Kettunen and Henttonen, 2010). So far metadata is an important field in ERM.

7. Information Technology Applications

Cluster 6 includes the article 3, 4 and 14 with the topic the applications of information technology. Ontology, information visualization, Internet, information technology and e-government are discussed in these three articles. Information technologies support the creation, archival, processing, transmittal, and sharing of electronic records among agencies, citizens and companies (Hu, Hsu, Hu and Chen, 2010). ERM applications used in institutions should be restructured providing an integrated and centralized digital recordkeeping system in order for controlling all records of the organization in all media and form (Külcü and Çakmak, 2010). Therefore, IT applications are critical to ERM.

4.2 Co-word Analysis

In co-word analysis, this study first isolates the noun terms in articles and accumulates the frequency of noun terms. Only nouns with high frequency are left. Then, using the concept of association rule method, this study computes the count of two terms appearing simultaneously in articles (Zong, 2013). The frequency of two terms which appear simultaneously in articles represents their closeness in co-word matrix. Finally, the co-word matrix of terms is aggregated into clusters by Ward's method. In this study, the title, keywords and abstract of 344 articles are used to count the frequency of noun terms. Twenty-seven terms with high frequency are left as described in Table 3.

| No | Keyword | Frequency | No | Keyword | Frequency |
|------|----------------------|-----------|------|-------------------------------|-----------|
| k20 | archive | 86 | k44 | archives management | 20 |
| k103 | records management | 61 | k40 | archiving | 20 |
| k106 | preservation | 52 | k39 | digital archive | 19 |
| k5 | information | 41 | k109 | digital collections | 15 |
| k104 | metadata | 38 | k24 | information management | 15 |
| k25 | digital preservation | 33 | k41 | case study | 14 |
| k105 | access | 32 | k42 | collaboration | 14 |
| k6 | digital libraries | 31 | k110 | government | 14 |
| k8 | electronic records | 28 | k111 | internet | 14 |
| k45 | libraries | 28 | k112 | recordkeeping | 14 |
| k46 | digital storage | 24 | k43 | history | 13 |
| k26 | repository | 23 | k23 | digital records | 12 |
| k38 | standards | 22 | k22 | electronic records management | 10 |
| | | | k21 | education | 9 |

Table 3.Terms with high frequency in selected articles

Using hierarchical clustering analysis, these 27 terms are aggrgated into eight clusters as described in Figure 2.



Figure 3. Hierarchical cluster of high-frequency terms

Eight clusters of terms with high frequency are described in Table 4 as follows:

1. Digital Preservation

Cluster 1 includes the terms K20, K5, K106 and K25 with the topic regarding digital preservation. Archive, information, preservation and digital preservation are the critical terms in this cluster.

2. Digital Repository

Cluster 2 includes the terms K46 and K44 with the topic regarding digital repository. Digital storage and archive management are the critical terms in this cluster.

3. Digital Collections

Cluster 1 includes the terms K109 and K42 with the topic regarding digital collections. Digital collections and collaboration are the critical terms in this cluster.

4. Internet Applications

Cluster 4 includes the terms K105, K39, K111 and K43 with the topic regarding Internet applications. Access, digital archive, internet and history are the critical terms in this cluster.

5. Archiving in Digital Library and Government

Cluster 5 includes the terms K103, K6, K110, K40 and K21 with the topic regarding Archiving in Digital Library and Government. Records management, digital libraries, government, archiving and education are the critical terms in this cluster.

6. Electronic Records Management

Cluster 6 includes the terms K112 and K2245 with the topic regarding electronic records management. Recordkeeping and electronic records management are the critical terms in this cluster.

7. Cases of Electronic Records

Cluster 7 includes the terms K8, K41, K23 and K24 with the topic regarding cases of electronic records management. Electronic records, case study, digital records and information management are the critical terms in this cluster.

8. Metadata and Standard

Cluster 1 includes the terms K104, K26, K45 and K38 with the topic regarding metadata and standard. Metadata, repository, libraries and standards are the critical terms in this cluster.

| Cluster No Cluster Name Keyword No Keyword | |
|--|-------|
| | |
| 1 Digital Preservation K20 archive | |
| K5 information | |
| K106 preservation | |
| K25 digital preservation | |
| 2 Digital Repository K46 digital storage | |
| K44 archive management | |
| 3 Digital Collection K109 digital collections | |
| K42 collaboration | |
| 4 Internet Applications K105 access | |
| K39 digital archive | |
| K111 internet | |
| K43 history | |
| 5 Archiving in Digital K103 records management | |
| Library and Government K6 digital libraries | |
| K110 government | |
| K40 archiving | |
| K21 education | |
| 6 Electronic Records K112 recordkeeping | |
| Management K22 electronic records manage | ement |
| 7 Cases of Electronic K8 electronic records | |
| Records K41 case study | |
| K23 digital records | |
| K24 information management | |
| 8 Metadata and Standard K104 metadata | |
| K26 repository | |
| K45 libraries | |
| K38 standards | |

Table 4.Clusters of high-frequency terms from co-word analysis

5 CONCLUSIONS AND IMPLICATION

Since the late 1990s, many government agencies have launched projects with a particular emphasis on using IT to provide electronic information and services to citizens and businesses (Chen and Gant, 2001). The fact that the majority of electronic records are less reliable, retrievable or accessible than ever before is one of the ironies of the modern information age. Idiosyncratic software systems generate, manage and store digital data using proprietary technologies and media that are not developed to segregate records from other types of information, to prevent manipulation or tampering, or to establish and maintain an intellectual order, and that are subject to the dynamism of the computer industry. This digital information cannot be considered trustworthy and is easily lost in a self-perpetuating and expensive cycle of obsolescence and incompatibility (Duranti, 2001).

The International Council on Archives (ICA) Guide notes that "the rapid proliferation of text and data files" made inventorying and preserving electronic records difficult, and turned archivists' attention to the question of developing policies and practices to ameliorate this decentralized and uncontrolled situation. With the growth of networking and the development of paperless transactions, archivists have become increasingly concerned about the long-term preservation of electronic records. A number of researches have been done on the topic regarding ERM.

Co-citation analysis, co-word analysis, association rule and cluster analysis are used in this study. From co-citation analysis, seven clusters are concluded as Digital Preservation, Digital Repository, Critical Projects, Archiving, Electronic Records Management, Metadata and Information Technology Applications. From co-word analysis, eight clusters are concluded as Digital Preservation, Digital Repository, Digital Collections, Cases of Electronic Records, Archiving in Digital Library and Government, Electronic Records Management, Metadata and Standard, and Internet Applications. The corresponding mapping of clusters from co-citation and co-word analysis is depicted in Table 5.

| Cluster # (Co-citation) | Cluster from Co-citation Analysis | Cluster # in (Co-word) | Cluster from Co-word Analysis |
|----------------------------|-------------------------------------|---------------------------|---|
| 1 | Digital Preservation | 1 | Digital Preservation |
| 2 | Digital Papasitory | 2 | Digital Repository |
| | Digital Repository | 3 | Digital Collections |
| 3 | Critical Projects | 7 | Cases of Electronic Records |
| 4 | Archiving | 5 | Archiving in Digital Library and Government |
| 5 | Electronic Records Management | 6 | Electronic Records Management |
| 6 | Metadata | 8 | Metadata and Standard |
| 7 | Information Technology Applications | 4 | Internet Applications |

 Table 5.
 The corresponding mapping of clusters from co-citation and co-word analysis

According to the perspective of concept-practice and technology-management, these clusters in ERM discipline could be classified into segments as depicted in Figure 4. Most ER researches are focused on the management in practical setting. Besides, there are more ER researches on the management field than that on the technology field. ERM researches should focus more on the technology field than the management field. Further study could investigate the intellectual structure effect on the articles from other publication database, e.g. Web of Science, for more information.

| Concept | 1.archive, information, preservation, | 6.electronic records management, |
|----------|---------------------------------------|---|
| | digital preservation | recordkeeping |
| | | 8.metadata, library, repository, standard |
| Practice | 4.digital archive, history, access, | 2.digital storage, archive management |
| | internet | 3.digital collection, collaboration |
| | | 5.digital library, government, archiving, |
| | | records management, education |
| | | 7.electronic records, digital records, case |
| | | study, information management |
| | Technology | Management |

Figure 4. Clusters of key terms in different segments

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