Organization of Complex Topics in Comprehensive Classification Schemes: Case Studies of Disaster and Security

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Abstract: This research investigates how comprehensive classifications and home-grown classifications organize complex topics. Two comprehensive classifications and two home-grown taxonomies are used to examine two complex topics: disaster and security. The two comprehensive classifications are the Library of Congress Classification and the Classification Scheme for Chinese Libraries. The two home-grown taxonomies are AIRS 211 LA County Taxonomy of Human Services – Disaster Services, and the Human Security Taxonomy. It is found that a comprehensive classification may provide many subclasses of a complex topic, which are scattered in various classes. Occasionally the classification scheme may provide several small taxonomies that organize the terms of a subclass of the complex topic that are pulled from multiple classes. However, the comprehensive classification provides no organization of the major subclasses of the complex topic. The lack of organization of the major subclasses of the complex topic may prevent users from understanding the complex topic systematically, and so preventing them from selecting an appropriate classification term for the complex topic. Ideally a comprehensive classification should provide a high-level conceptual framework for the complex topic, or at least organize the major subclasses in a way that help users understand the complex topic systematically.

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1.0 Introduction

A complex topic is operationally defined here as a topic that has many subtopics, dimensions, aspects or facets, such as security and disaster. A classification scheme or taxonomy may be created for a complex topic in order to understand the topic systematically and manage the topic for serving the society. To create such a classification or taxonomy, one would obtain knowledge about the topic from domain experts, relevant literature, and comprehensive classification schemes. According to Bowker and Star (1999, 10), "a classification is a spatial, temporal, or spatio-temporal segmentation of the world. A classification system is a set of boxes (metaphorical or literal) into which things can be put to then do some kind of work – bureaucratic or knowledge production". According to Taylor (1992, 319), "Established philosophical systems of knowledge, with various modifications, underlie most traditional library classifications ... Philosophical classification organizes knowledge itself – registering, evaluating, and classifying thoughts, ideas, and concepts for the universal purpose of adequately representing the field of human learning". Therefore, traditional li-

brary classification schemes record and organize knowledge in the world. A comprehensive classification scheme may provide some knowledge about complex topics. This paper aims to examine how comprehensive classification schemes organize knowledge about complex topics, find deficiencies in comprehensive classification schemes when organizing knowledge about complex topics, and then provide suggestions on improving the organization of complex topics in comprehensive classification schemes.

According to Koch (1997), there are broadly four varieties of classification schemes: universal schemes (such as the Library of Congress Classification, the Dewey Decimal Classification), national-level general schemes (which are universal in subject coverage but usually designed for use in a single country or region), subject specific scheme (which are designed for use by a particular subject community), and home-grown schemes (which are designed for use in a particular service (Taylor 1999). In this study, we use a universal scheme – the Library of Congress Classification (LCC), a national-level general scheme – the Classification Scheme for Chinese Libraries (CCL), and for comparison, two home-grown schemes: Human Security Taxonomy (HST), and AIRS 211 LA Human Services Taxonomy Disaster Services (AIRS-HSTDS). In this paper, for convenience purpose, the first two classification schemes are called comprehensive classification schemes, and the latter two taxonomic schemes are called home-grown taxonomic schemes. A distinction between classification and taxonomy is discussed in Section 2.1. We will use these four schemes to examine two complex topics: disaster and security.

Disaster is a complex topic because there are two types of disaster: natural and man-made, and there are various types of natural disasters and man-made disasters. A natural disaster is caused by natural factors (such as earthquake, flood, and cyclone), and a man-made disaster is caused by human activities (such as wars, fire accidents, and industrial accidents) (Haygot Technologies 2020), therefore disaster has many subtopics. Security is a complex topic because there are various definitions and dimensions of security, and there is no comprehensive taxonomy of security yet (Wu and Meng 2018). Table 1 shows various dimensions of security from various security perspectives.

This paper is organized as follows. Section 2 reviews related literature. Section 3 introduces research question, novelty and significance. Section 4 introduces method, including instrument, data collection and analysis. Section 5 presents findings and discussions. Section 6 highlights theoretical and practical implications of the findings. Section 7 concludes the paper with a discussion of limitations and future studies.

2.0 Related work

2.1 Classification and taxonomy

There are many definitions of classification. Hjørland (2017) provides a comprehensive list of definitions of classification. Here I present a couple of definitions of classification that are closely related to this study. According to Vickery (2008, 145-6), "a classification is a hierarchical structure of symbolic terms. The symbols point to, or represent, entities in the real or an imagined world". The definition is about entity classification. According to Soergel (2004, 358), "a classification is a structure that organizes concepts into a meaningful hierarchy, possibly in a scheme of facets. The classification of living things is a taxonomy. (The term taxonomy is increasingly used for any type of classification.)". Slavic (2000) makes a distinction between knowledge classification and bibliographic classification:

> Knowledge classification can be, and often is, taxonomic (sometimes called 'entity classification') like the classification of zoology, classification of plants, or classification of chemical elements (which means that they are going to list one concept in one place only in the classification structure). Bibliographic classifications, i.e., those one has to use to describe real documents are not and cannot be taxonomic.

Major Dimensions of Security	Other Dimensions of Security
Economic security	Individual security
Human security	Community security
International security	Ecological security
Military security	Food security
Political/cultural security	Global security
Resource/environmental security	Health security
State/National security	Personal security
	Regional security
	Social security
	Societal security

Table 1. Some examples of security dimensions. Source: Wu and Meng (2018).

> They are by all means aspect or disciplinary classifications. This means that they will list one concept in all disciplines and fields where that concept might be studied: e.g., 'water' will have to appear under chemistry, physics, in geology, medicine, sport etc.

In this paper, the two comprehensive classification schemes (i.e., LCC and CCL) are bibliographic classifications, whereas the two home-grown taxonomic schemes (i.e., HST, AIRS-HSTDS) are knowledge classifications.

Adams and Adams (1991, 202-3) makes a distinction between classification and taxonomy:

> The term taxonomy, like other words relating to classification, has no generally accepted, precise definition. For many systematists, especially in the biological sciences, it is synonymous with classification itself ... We apply the term only to classificatory systems having an explicit hierarchic feature; that is, systems in which basic types are either clustered into larger groups or split into smaller ones, or both. Most of the time, taxonomic ordering is simply the classification of classes: the clustering of basic types into larger and more inclusive units on the basis of some but not all of their attributes.

In this paper, the general distinction between classification and taxonomy in organizing classes and taxons is not highlighted. Instead, the specific distinction between the two comprehensive classifications and the two home-grown taxonomies in organizing the subclasses of the two complex topics is examined.

Before studying the two complex topics, we need to introduce the four classification schemes. LCC was developed to organize and arrange the book collections of the Library of Congress. The system divides all knowledge into twenty-one basic classes. It is currently one of the most widely used library classification systems in the world (Library of Congress 2022). CCL is a bibliographic classification system for organizing and arranging Chinese books. It is designed by the National Library in Taiwan based on LCC, the Dewey Decimal Classification (DDC), and Chinese ancient classifications (National Library 2007). The system divides all knowledge into nine main classes.

The AIRS 211 Los Angeles County Taxonomy of Human Services – Disaster Services (AIRS-HSTDS) section was developed in conjunction with the Alliance of Information and Referral Systems (AIRS) National Emergency Resource Information Network (NERIN) project in the mid-1990s with an aim to "develop a national model for an Internet-based human services information infrastructure that enables I&R (information and referral) programs to respond effectively with appropriate information when a disaster occurs"(211 LA County 2022). The taxonomy has seven main classes or taxons.

There is no home-grown taxonomy for security yet. Fortunately, there is a home-grown taxonomy for human security, the Human Security Taxonomy (HST) (Worldwide Human Geography Data Working Group 2013). Human security has two main aspects. It means, "first, safety from such chronic threats as hunger, disease, and repression. And second, it means protection from sudden and hurtful disruptions in the patterns of daily life – whether in homes, in jobs or in communities"(UNDP 1994, 23). Most threats to human security "can be considered under several main categories: economic security, food security, health security, environmental security, personal security, community security, political security"(UNDP 1994, 24-5). An ideal, full-blown taxonomy of human security should include the following subtopics: disaster risk reduction, emerging disease detection, hazard preparedness and response, humanitarian assistance and disaster relief, national recovery and reconstruction, capacity building, job creation, economic resilience, ecosystem services, public health, political stability, communication security, transportation security, infrastructure security, water security, energy security, and food security (Worldwide Human Geography Data Working Group 2013). However, HST is not a full-blown taxonomy of human security, and focuses on several aspects of human security: disaster risk reduction, hazard preparedness and response, and humanitarian assistance and disaster relief.

The Human Security Taxonomy (HST) was designed by the Worldwide Human Geography Data Working Group from 2010 to 2012 at the request of the U.S. government. It "addresses the information needs of disaster professionals during pre-event hazard mitigation, material pre-positioning, and the response phase of an emergency ... it is a list designed for data collection in preparation for a disaster. The focus is infrastructure awareness in support of people serviced by that infrastructure, with special attention to intersecting nodes with extended influence" (Worldwide Human Geography Data Working Group, 2013). The taxonomy has 14 base taxons, listing the major aspects related to disaster preparation, and 28 GIS taxons, listing the major risks from disasters, and facilities and capacities for disaster preparation, response, and recovery.

2.2 Critical analysis of classifications and subject headings

Previous studies on critical classification indicate that classifications may be incomplete, may take a certain political position, follow a certain theory, and may be biased. Ideally classifications should carry balanced perspectives that reflect multiple points of views if there are different value judgments so that they can be applied to broad scope of ap-

plication contexts. However, a philosophical classification reflects a particular perspective of knowledge of the creator of the classification and may have embedded subjective value judgments or biases.

Knowledge organization systems such as classifications may include systematic biases. Olson (2001) argued that classifications embody the biases most common in the culture of a society. Olson and Schlegl (1999) documented bias in the placement of topics outside of mainstream culture of North American and European and the omission of topics associated with marginalized people. Foskett (1984) explained that this bias exists because classifications reflect the view and values of the creators of the classifications. Adler (2017) discusses the processes by which racism becomes systemic on library shelves and contends that systemic violence is a classification problem. Mai (2016, 324) introduced Hope Olson's (2010) work on marginalization and exclusion of specific topics and groups of people in large library classification and demonstrated how Olson's work "has unraveled the systemic bias found in all classifications". Gutiérrez and Martínez-Ávila (2014, 214) studied the subjectivity of the opinions and biases of media knowledge organization systems (MKOS), and found that "MKOS not only reproduce the information and opinion of the media authors (reporters, columnists, editors, etc.) in the metadata, but also produce their own bias and opinions". Thornley et al. (2022, 1462) discussed cultural bias in library classification systems, such as DDC and Library of Congress Subject Headings (LCSH), and "the potential cultural and psychological harm of inappropriate terminology and inaccurate positioning within 'worlds of knowledge'". Baker and Islam (2020) identified three significant biases in the entire section of religion in LCC: unequal real estate, ethnocentric category boundaries, and assumed universal categories. Satija (2013, 287) reported the changes of Dewey Decimal Classification (DDC) from the 19th (1979) to the 23rd edition (2011) and noted the reduction of Christian bias in religion and U.S. bias in public administration, and "moving towards internationalization by gradually removing White, Anglo-Saxon and Protestant (WASP) bias" in the schedules and tables.

Systematic bias in knowledge organization system is also presented by the exclusion of certain groups of people. Investigation into the treatment of indigenous peoples in the U.S. from DDC 16 to DDC 23 reveals that DDC fails to recognize indigenous people as sovereign nations (Green 2015). Higgins (2016) reported that Asian American representation in DDC, 1876-1996 was invisible. Howard and Knowlton (2018, 77) found that, when organizing information about lesbian, gay, bisexual, transgender, queer (and/or questioning), intersex, and asexual (LGBTQIA) studies, LCSH exhibits "othering" tendencies, that is, "presenting historically marginalized people" (such as LGBTQIA people) as "different from white heterosexual men".

Ideally a classification system is complete. According to Bowker and Star (1999, 11), "with respect to the items, actions, or areas under its consideration, the ideal classification system provides total coverage of the world it describes. So, for example, a botanical classifier would not simply ignore a newly discovered plant, but would always strive to name it". Taylor (1992, 320) argues that a classification system "must be inclusive as well as comprehensive. It must encompass the whole field of knowledge as represented in collectible media of communication and information. It must therefore include all subjects that are, have been, or may be recognized, allowing for possible future additions to the body of knowledge. It must make provision, not only for the records themselves, but also for every actual and potential use of the records. However, "no real-world working classification system meets this requirement" (Bowker and Star 1999, 11). "No classification of limited size can anticipate or list all topics" (Evans et al. 2011). "There may be good reasons to ignore data that would make a system more comprehensive. The discovery of a new species on an economically important development site may be silenced for monetary considerations. An anomaly may be acknowledged, but be too expensive, politically or bureaucratically, to introduce into a system of record keeping" (Bowker and Star 1999, 12). Merkley (2011) analyzed the topical coverage of the three major classification systems, LCC, DDC, and Universal Decimal Classification (UDC), and found that none of them provides complete and systematic coverage of the world of knowledge. For example, the coverage of religion in LCC and DDC focuses on Christianity and presents incomplete coverage of other faiths. Attention needs to be paid to these conceptual, organizational, and political dimensions of classifications.

This study also performs a critical analysis of classifications, but does not aim to reveal their subjective judgments, biases, and incompleteness. This study investigates how comprehensive classification schemes organize complex topics such as disasters and security, compared with home-grown taxonomic schemes in two case studies.

3.0 Research question, novelty, and significance

This study's research question is: how do comprehensive classification schemes organize complex topics such as disaster and security, compared with home-grown taxonomic schemes that are built by particular communities for the complex topics?

The research question itself is novel. It is also novel in the sense that comprehensive classifications are compared with home-grown taxonomies when organizing complex topics so that the judgment of the organization of complex topics in comprehensive classifications is not totally subjective or arbitrary. The research question is significant to the library

and information science community in two senses. First, since comprehensive bibliographic classifications serve as indexing tools, a cataloger or indexer needs to understand a complex topic in its organization system before selecting an appropriate indexing term (i.e., class label) for the topic. The question is: does the comprehensive classification organizes the complex topic to support the cataloger or indexer? Second, if the answer to the question is negative, the knowledge organization community will need to examine those complex topics in classification schemes and if possible, make efforts to improve the classifications. Helping the cataloger or indexer to understand the scope (i.e., facets) and depth (i.e., subtopics) of a complex topic assists the indexer to select an appropriate index term (i.e., class label).

4.0 Method

4.1 Instrument

To answer the research question, we use two comprehensive classifications (i.e., LCC and CCL) and two home-grown taxonomies (i.e., AIRS-HSTDS and HST) to examine two complex topics: disaster and security. Disaster and security are selected in this study because they have many subtopics in LCC and CCL, and a disaster taxonomy (i.e., AIRS-HSTDS) and a human security taxonomy (i.e., HST) are available for this study. LCC was selected in the study because it is a famous, representative universal scheme. CCL was selected because it is a representative, national-level general scheme with a different cultural background from LCC. Even though it is written in Chinese, the majority of its terms has an English translation, which is convenient to both the researcher and the readers. HST and AIRS-HSTDS were selected because they are home-grown taxonomies available for this study. Another reason that these four schemes were selected is that they are all available on the Web, which is convenient to both the researcher and the readers.

Two case studies were implemented. In the first case study, LCC, CCL and AIRS-HSTDS were used to examine how disaster and its subtopics are organized. In the second case study, LCC, CCL, and HST were used to examine how security and its subtopics are organized.

4.2 Data collection and analysis

In Case Study 1, disaster and its subtopics were collected from LCC and CCL. Disaster and its subtopics were collected from LCC by searching for "disaster" in LCC. They were collected from CCL by searching for "disaster" and the term "灾害" (disaster in traditional Chinese characters) in CCL since occasionally there are terms in CCL not translated into English. In Case Study 2, security and its subtopics were collected from LCC and CCL. Security and its subtopics were collected from LCC by searching for "security" in LCC. The term "safety" was not searched in LCC because there are already many security terms in LCC. There are a much fewer number of "security" terms found in CCL than in LCC. The term "安全" (security or safety in traditional Chinese characters) can be translated into security or safety, therefore security, safety, and their subtopics were collected from CCL by searching for "security", "safety" and "安全" (security or safety in traditional Chinese characters) in CCL since occasionally there are terms in CCL not translated into English. Data collection was implemented in 2022.

The two complex topics were analyzed by showing major subclasses of each topic in LCC and CCL, the organization of subclasses of each topic in LCC and CCL, and the organization of the disaster in AIRS-HSTDS and the organization of human security in HST. Only a small portion of AIRS-HSTDS and HST is shown for comparison purpose.

4.2.1 Case study 1: Disaster

Table 2 shows that 18 major disaster subclasses are scattered in 15 top classes or subclasses in LCC. For example, the BF789.D5 Disasters subclass is in the BF class, whereas the BL65.N33 Natural disasters subclass is in the BL class. Only a portion of the disaster subclasses is shown in the table for demonstration purposes.

Table 3 shows five small taxonomies of disaster and its subclasses or subtopics in LCC, which demonstrate the organization of the disaster subclasses and subtopics. These small taxonomies may help users understand what concepts or subtopics are included in a certain subclass. For example, the Natural Disasters taxonomy pulls specific natural disaster terms (such as floods, tidal waves) from multiple top classes or subclasses such as GB, GC, GF, HV, QC, QE, QH, SD, and TF. There are also locally organized taxonomies. For example, the terms under the "Relief in case of disasters" taxonomy are all from the HV554 subclass.

Table 4 shows that 19 major disaster subclasses are scattered in 13 top classes in CCL. For example, the 433 Agrometeorology and disasters subclass is in the Applied sciences class, whereas the 412.57 Disaster medicine is in the Medical Sciences class.

Table 5 shows several small taxonomies of disaster subclasses, which demonstrate the organization of the disaster subclasses in CCL. Each of these small taxonomies organizes its members locally, usually in the same subclass. For example, the terms under 433.1 Natural disasters and control subclass are all from the 433 subclass. Taxonomies that organize terms from multiple classes are not found in CCL.

Major Disaster Subclasses in LCC	**In LCC Top Classes or Subclasses**
BF789.D5 Disasters	BF PSYCHOLOGY
BL65.N33 Natural disasters	BL RELIGIONS. MYTHOLOGY. RATIONALISM
KF320.E44 Emergency management. Disaster preparedness	KF UNITED STATES (GENERAL)
LB3250 Damages from disasters	LB THEORY AND PRACTICE OF EDUCATION
KJV5740 Agricultural disasters (Table K11)	KJV LAW OF FRANCE
KK6235 Disaster medicine	KK LAW OF GERMANY
TA495 Disasters and engineering	TA ENGINEERING (GENERAL). CIVIL ENGINEERING (GENERAL)
TP150.A23 Accidents. Disasters	TP CHEMICAL TECHNOLOGY
VK1265 Submarine disasters	VK NAVIGATION. MERCHANT MARINE
BV4596.D57 Disaster victims	BV PRACTICAL THEOLOGY
BF723.D5 Disasters (Reaction to)	BF PSYCHOLOGY
GE146 Environmental disasters	GE ENVIRONMENTAL SCIENCES
G1.E29 Demographic aspects of disasters	GE ENVIRONMENTAL SCIENCES
HC79.D45 Disasters, Economic impact of	HC ECONOMIC HISTORY AND CONDITIONS
HG9979-9979.4 Disaster insurance	HG FINANCE
KBM3037 Emergency management. Disaster control. Disaster relief	KBM JEWISH LAW. HALAKHAH.
KF21.H6316 Disaster Recovery KF21.P827 Disaster Relief	KF LAW OF THE UNITED STATES KF 21 SENATE STANDING COMMITTEE (TABLE)

Table 2. Major disaster subclasses scattered in LCC.

Several Disaster Taxonomies in LCC	**In LCC Top Classes or Subclasses**
Storms. Cyclones Cf. GC225+ Storm surges Cf. HV635.5+ Disaster relief and socioeconomic consequences Cf. QC926.3+ Snow. Ice. Blizzards Cf. QC968+ Thunderstorms	QC PHYSICS Meteorology. Climatology
Natural Disasters Cf. GB1399+ Floods Cf. GC219+ Tidal waves Cf. GC225+ Storm surges Cf. GF85 Hazardous environments (Human ecology) Cf. HV8080.D5 Disaster operations (Police work) Cf. QC929.A8 Avalanches Cf. QC940.6+ Storms Cf. QE521+ Volcanoes and earthquakes Cf. QE598+ Earth movements Cf. QH545.N3 Effect on plants and animals Cf. SD420.5+ Forest fires Cf. TF539 Damage to railroads	GB PHYSICAL GEOGRAPHY
TA495 Disasters and engineering Cf. TC181 Earthquakes and hydraulic structures Cf. TC530+ Flood control Cf. TH1095 Earthquakes and building	TA ENGINEERING (GENERAL). CIVIL ENGINEERING (GENERAL)
Relief in case of disasters HV554.4 Church and disaster relief. Church work with disaster victims HV554.5 Emergency housing HV554.6 Disaster justice	HV SOCIAL PATHOLOGY. SOCIAL AND PUBLIC WELFARE. CRIMINOLOGY

Table 3. Several disaster taxonomies in LCC.

Major Disaster Subclasses in CCL	**In CCL Top Classes**
433 Agrometeorology and disasters	Applied sciences
412.57 Disaster medicine	Medical sciences
430.5 Farming and fisheries natural disaster relief	Agriculture
433.09 Agricultural disaster history	Agriculture
433.1 Natural disasters and control	Agriculture
433.7 Agricultural disaster control	Agriculture
436.31 Forest natural disaster and control	Agriculture
445.5 Safety engineering; Disaster prevention engineering	Engineering
452.9 Mine disaster and safety	Mining and metallurgy
563.759 Disaster insurance, Including wind damages, flood, earthquake	Finance
328.98 Meteorological disaster chronicles Divide by countries and regions in the world	Astronomy
340.2 Handbook for treatment of chemical accident; Laboratory safety manual	Chemistry
354.18 Volcano disaster 354.48 Engineering earthquake	Earth science
367.28 Natural disasters	Biological science
430.5 Farming and fisheries natural disaster relief	Agriculture
447.88 Aviation disaster and salvage	Engineering
457.88 Natural gas disaster and safety	Mining and metallurgy
548.31 Disaster relief	Sociology
557.909 Aviation history Including aviation records, aviation disaster cases	Economy

Table 4. Major disaster subclasses in CCL.

Several Disaster Taxonomies in CCL	**In CCL Top Classes and Subclasses**
433.1 Natural disasters and control 433.11 Chilly injuries including low temperature, frost, hail 433.15 Wind damages 433.16 Flood damages 433.17 Drought and heat damages 433.18 Fire damages 433.19 Air pollution	Agriculture 433 Agrometeorology and disasters
354.18 Volcano disaster 354.48 Engineering earthquake Including earthquake, earthquake prevention, and earthquake resistance	Earth science Geology 354 Dynamic geology
367.28 Natural disasters Including fire, flood, drought, blizzard, hurricane.	Biological science 367 Ecology
548.31 Disaster relief 548.313 From drought, famines 548.314 From floods 548.315 From storms; From snow 548.316 From fire 548.317 From earthquakes 548.318 From effects of war	Sociology 548 Social pathology and relief

Table 5. Organization of disaster subclasses in CCL.

Table 6 shows the top taxons of AIRS-HSTDS, and a small portion of the Disaster Warnings Sub-taxons of AIRS-HSTDS. The AIRS-HSTDS top taxons provide a conceptual framework of the disaster services that are included in the taxonomy. The Disaster Warnings Sub-taxon lists both natural disaster and man-made disaster subtopics although the category labels of "natural disaster" and "man-made disaster" are not present. By browsing the taxonomy, readers can see the major taxons of disaster services, and the terms under each taxon in the hierarchical structure.

4.2.2 Case study 2: Security

Table 7 shows that 14 major security subclasses are scattered in 14 top classes or subclasses in LCC. For example, the AM148 Security measures subclass is in the AM class, the HD61.5 Security measures subclass is in HD class, whereas the JC576 Human security subclass is in the JC class. There is a "human security" subclass, but its subtopics are not developed in LCC. Only a portion of the security subclasses is shown in the table for demonstration purposes.

Table 8 shows four small taxonomies of security subclasses, which demonstrate the organization of the security subclasses in LCC. These small taxonomies may help users understand what concepts or subtopics are included in a certain subclass. For example, the Private security services taxonomy pulls specific related security terms (such as retail trade security measures) from multiple top classes or subclasses such as HF, LB, and TH. There are also locally organized taxonomies. For example, the terms under the Z7164.I7 Insurance subclass are all from the Z7164 subclass.

Table 9 shows that eight major security subclasses are scattered in five top classes in CCL. There are fewer num-

AIRS-HSTDS Top Taxons	TH-2100 Disaster Warnings Sub-taxon (a portion)
TH-1500 Disaster Management Organizations	TH-2100.0500 Avalanche Warnings
TH-1700 Disaster Preparedness	TH-2100.1500 Civil Unrest Advisories
TH-1800 Disaster Mitigation	TH-2100.1800 Earthquake Advisories
TH-2100 Disaster Warnings	TH-2100.2000 Fire Advisories
TH-2300 Disaster Response Services	TH-2100.4500 Landslide/Mudslide Advisories
TH-2600 Disaster Relief Services	TH-2100.8500 Tsunami Advisories
TH-2900 Disaster Recovery Services	TH-2100.9000 Volcanic Eruption Advisories
	TH-2100.9500 Weather Advisories
	TH-2100.9500-150 Cold Weather Advisories
	TH-2100.9500-160 Drought Advisories
	TH-2100.9500-170 Extreme Heat Advisories/Warnings
	TH-2100.9500-200 Flood Advisories

Table 6. AIRS-HSTDS Top taxons and a snippet of its disaster warnings sub-taxon.

Major Security Subclasses in LCC	In LCC Top Classes or Subclasses
AM148 Security measures	AM MUSEUMS. COLLECTORS AND COLLECTING
BL65.S375 Security, International	BL RELIGIONS. MYTHOLOGY. RATIONALISM
BP190.5.S57 Social security	BP ISLAM. BAHAI FAITH. THEOSOPHY, ETC.
HD61.5 Security measures	HD INDUSTRIES. LAND USE. LABOR
KJV397.S43 Security	KJV LAW OF FRANCE
J10 3.5.I67 Internal security	J10 TABLE FOR POLITICAL INSTITUTIONS AND PUBLIC ADMINISTRATION
JC576 Human security	JC POLITICAL THEORY. THE STATE. THEORIES OF THE STATE
JZ6005 Post-Cold War security	JZ INTERNATIONAL RELATIONS
KK82.S62 Social legislation. Social security	KK LAW OF GERMANY
KI282.F66 Food sovereignty. Food security	KI LAW OF INDIGENOUS PEOPLES
K1519.C6 Computer security (Computer programs)	K LAW IN GENERAL. COMPARATIVE AND UNIFORM LAW. JURISPRUDENCE
KJ-KKZ1 130 Job security	KJ-KKZ1 EUROPE: COUNTRIES (5000 NOS.)
HC79.E36 Economic security	HC ECONOMIC HISTORY AND CONDITIONS
HD30.38 Computer network security	HD INDUSTRIES. LAND USE. LABOR

Table 7. Major security subclasses in LCC.

Several Security Taxonomies in LCC	In LCC Top Classes and Subclasses (a portion)
Z7164.I7 Insurance Cf. Z7164.A17 Accident insurance Cf. Z7164.G83 Group insurance Cf. Z7164.S6635 Social security Cf. Z7164.U56 Unemployment insurance Cf. Z7164.W67 Workers' compensation	Z SUBJECT BIBLIOGRAPHY Political and social sciences
Private security services Including guards, watchmen, private police, protection of factories and public buildings, campus police Cf. HF5429.27 Retail trade security measures Cf. HF5549.5.E43 Employee theft Cf. LB2866 School and campus security Cf. TH9701+ Security equipment in buildings	HV SOCIAL PATHOLOGY. SOCIAL AND PUBLIC WELFARE. CRIMINOLOGY
JZ5107 Category VII: Security Council and peace-keeping operations JZ5420 Organization for Security and Cooperation in Europe JZ5576 War Resisters International JZ4971 International security, disarmament, and conflict resolution JZ5531.N3 National Security Affairs Conference JZ5584.A-Z By region or country, A-Z International security. Disarmament. Global survival	JZ INTERNATIONAL RELATIONS
Protection from burglary, sabotage, etc. Security in buildings Cf. HV6646+ Theft Cf. HV8290+ Guards, watchmen, etc.	TH BUILDING CONSTRUCTION

Table 8. Organization of security subclasses in LCC.

Major Security Subclasses in CCL	In CCL Top Classes
451.8 Mining security	Mining and metallurgy
452.9 Mine disaster and safety	Mining and metallurgy
548.9 Social security	Sociology
578.152 Security council	Political science
579.36 International security	Political science
599.7 National security 599.79 National security of various countries	Military science
599.73 Security organizations	Military science
312.76 Data Security	Mathematics

Table 9. Major security subclasses in CCL.

bers of major security subclasses in CCL than those in LCC. No taxonomies under any security subclass are developed in CCL. That is, security is a less developed topic in CCL than in LCC.

Table 10 shows the base taxons of HST, and the terms under the sub taxon of "Hazard and Conflict". The HST base taxons provide a conceptual framework of human security. By browsing the taxonomy, readers can see the major aspects and subtopics of human security, and the terms under each subtopic in the hierarchical structure.

5.0 Findings and discussions

In the case study of disaster, from Table 2 to Table 5, we see that both LCC and CCL have many major disaster subclasses, which are scattered in multiple top classes or subclasses. LCC organizes several small taxonomies that pull the members of a taxonomy from multiple top classes or subclasses. LCC also has locally organized small taxonomies that list the members of a taxonomy from the same top class or subclass. In comparison, CCL does not organize small taxonomies that pull the members of a taxonomy from multiple top classes or subclasses. CCL provides only locally organized small taxonomies that list the members of a taxonomy from the same top class or subclass. From Table 6, we see that AIRS-HSTDS provides both a conceptual framework of the major facets or topics of disaster services and a hierarchical structure that organizes a relatively complete list of subtopics of disaster services. In comparison, neither LCC nor CCL develops the disaster topic as fully as AIRS-

HST Base Taxons	HST Hazard and Conflict Sub-taxons	
A Boundaries	M	Hazard and Conflict
B Place names	M1	Avalanche
C Road networks	M2	Biological/Medical
D Hydrography	M3	Chemical
E Elevation data	M4	Fire
F Imagery	M5	Flood
G Climate and weather	M6	Landslide
H Geology	M7	Radiological
I Geography (physical)	M8	Storm
J Land use	M9	Volcano
K Oceans and Coastlines	M10	Wind
L Conservation areas	M11	Conflict, active
M Hazard and Conflict Impact Maps	M12	Post-conflict environment
N Health risks		

Table 10. HST top taxons and a sub-taxon.

HSTDS. Neither LCC nor CCL provides a conceptual framework of the disaster topic, or systematically organizes all the disaster subtopics that are included in either classification scheme.

Security is a more complex topic than disaster since security has more dimensions or facets than disaster. In the case study of security, from Table 7 to Table 9, we see that both LCC and CCL provide a sporadic coverage of the security landscape (when compared with major security dimensions shown in Table 1). Both LCC and CCL provide some major security subclasses, which are scattered in various top classes or subclasses. LCC organizes a small taxonomy of the Private security services that pull the members of the taxonomy from multiple top classes or subclasses. LCC also has locally organized small taxonomies that list the members of a taxonomy from the same top class or subclass. In comparison, CCL has much fewer number of major security subclasses than LCC and does not organize any small taxonomy that pulls the members of a taxonomy from multiple top classes or subclasses. CCL has only locally organized small taxonomies that list the members of a taxonomy from the same top class or subclass. From Table 10, we see that HST provides both a conceptual framework of the major facets or topics of human security and a hierarchical structure that organizes a relatively complete list of subtopics of human security. In comparison, LCC does not develop the human security topic. That is, LCC does not have subtopics under human security. CCL does not include the human security topic at all. Neither LCC nor CCL provides a conceptual framework of the security topic, or systematically organizes all the security subtopics that are included in either classification scheme.

CCL contains fewer number of security terms than LCC. Interestingly, HST contains fewer types of disasters and hazards than AIRS-HSTDS. This confirms the known issue of incompleteness in classifications as discussed in Bowker and Star (1999) and Evans et al. (2011).

If a comprehensive classification (such as LCC or CCL) is a large tree, disaster and security subclasses are very often treated like tree leaves or leave clusters scattered on various tree branches. Such lack of organization does not help users to understand the complex topics systematically. Ideally both LCC and CCL should provide a high-level conceptual framework of complex topics such as disaster and security, or at least organize the major disaster subclasses and major security subclasses in a way that helps users to get an overview of the major dimensions (or facets) of these complex topics. We cannot expect a comprehensive classification to develop and organize a complex topic as broadly and deeply as a home-grown taxonomy developed for the complex topic. However, we hope a comprehensive classification can organize the terms of a complex topic that are included in the classification in some way.

The existence of a home-grown taxonomy for a topic indicates that the topic is complex and worth a specific study. The existence of many subtopics of a topic in a comprehensive classification also indicates the topic may be complex. A possible solution to the problem of lack of organization of major subclasses of a complex topic in comprehensive classifications is, when the comprehensive classification is under revision, the reviewers could investigate the complex topics, and try to provide some organization, or even a high-level conceptual framework, of the topic.

6.0 Theoretical and practical implications

Classification systems are used in the information community to organize information and to provide access to the organized information. Classification systems may also be used to help users to understand a topic and form a discus-

sion on the topic. The lack of organization of major subclasses of a complex topic may prevent users from understanding the complex topic systematically, and so may also prevent users from selecting appropriate index terms (i.e., class labels) for the complex topic. If the comprehensive classification is used for education purpose, they may fail to help users understand the complex topic due to the lack of organization of major dimensions (or facets) of the topic.

7.0 Conclusion, limitations, and future work

From the two case studies of two complex topics (i.e., disaster and security), we conclude that a comprehensive classification such as LCC or CCL provides many subclasses of a complex topic, which are scattered in various classes. Occasionally the classification scheme may provide several small taxonomies that organize the terms of a subclass of the complex topic that are pulled from multiple classes. However, the comprehensive classification provides no organization of the major subclasses of the complex topic globally in the two case studies. The lack of organization of the major subclasses of the complex topic may prevent users from understanding the complex topic systematically, and so preventing them from selecting an appropriate index term or class label for the complex topic. Ideally a comprehensive classification should provide a high-level conceptual framework for the complex topic, or at least organize the major subclasses of the topic that are included in the classification in some way that help users understand the complex topic systematically.

This study has several limitations. First, this research investigates only two comprehensive classifications and two home-grown taxonomies, and their treatment of only two complex topics, therefore the findings may not be generalized. Second, the implications of the findings are logically inferred and hypothetical and may require validation with real users of the classifications. Third, it does not reveal why comprehensive classifications do not organize the subclasses of a complex topic. An investigation with the creators of the classifications may be needed.

In the future, we plan to study more classification schemes and more complex topics, study the users of the classifications to understand the impacts of the classifications when dealing with complex topics, and study the creators of the classifications to understand why the comprehensive classifications fail to organize the major subclasses of a complex topic.

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