Research methods: What's in the name?

Heting Chu[a,*], Qing Ke[b]

[a] *Palmer School of Library and Information Science, Long Island University, 720 Northern Boulevard, Brookville, NY 11577, United States*
[b] *School of Information Management, Nanjing University, 163 Xianlin Road, Nanjing 210093, China*

ABSTRACT

Research methods are applied in all kinds of studies, though no consensus exists regarding what constitutes a research method and how research methods should be categorized. Over 1900 research articles were obtained from three major journals published between 2001 and 2010 in library and information science (LIS). Each selected article was coded using a schema of research methods developed in this study. The coded data, along with related publications, were analyzed qualitatively and quantitatively. This exploration shows that research methods comprise data collection techniques (e.g., interview, observation) and data analysis techniques (e.g., qualitative, quantitative). Research methods should perhaps be categorized by data collection technique, as it makes more sense than if research methods are labeled as qualitative or quantitative. This study is one of the many efforts to facilitate a better understanding of research methods in LIS and help scholars make more informed decisions about research method selection in their endeavors. Its implications can be extended to LIS research education, training, and advocacy. Because research methods themselves are not discipline-specific, researchers beyond the LIS field would benefit from this study as well.

1. Introduction

Researchers need to consider and choose one or more methods for their scholarly endeavors based on what they intend to study. This is true for all scientific disciplines, including library and information science (LIS). Although a good number of studies have explored the topic of research methods adopted in the LIS field in past decades, three kinds of variations are commonly observed in practice and discourse.

First, a variety of terms other than *research methods* are used in the literature to refer to this concept. Sample terms include research strategies (Järvelin & Vakkari, 1990), research frameworks (White & Marsh, 2006), research designs (Luo & McKinney, 2015), and research methodologies (Hildreth & Aytac, 2007; Peritz, 1977).

Second, different criteria are applied in categorizing research methods. Some studies (Chu, 2015) categorize research methods by data collection technique (e.g., interview, observation, questionnaire) while others (Powell, 1999) use data analysis technique (e.g., quantitative, qualitative). It should be noted that the words *methods* and *techniques* are essentially used synonymously. In the present study, for the purpose of clarification, methods is used to cover the entire research process while techniques is used to refer to specific procedures for data collection or analysis. In most reported research, additional criteria are often applied when categorizing research methods. For instance, Järvelin and Vakkari (1990) group research methods by research

strategy (e.g., empirical, conceptual). The temporal criterion is sometimes employed to have cross-sectional studies and longitudinal studies (Chen & Hirschheim, 2004). Case study appears in many research reports as one type of research method (Bernhard, 1993; Gelber, 2013) although it only denotes that the research involves one or several cases (i.e., sampling units) as research subjects.

Third, assorted lists of research methods are developed in different studies due to the two kinds of variations depicted above. Each study creates its own unique array of research methods unless, for example, a later study adopts the same classification scheme developed for an earlier project (e.g., Kumpulainen, 1991, used a scheme developed by Järvelin & Vakkari, 1990).

All of these variations are results of different understandings and interpretations of what constitutes a research method and how research methods should be categorized. They can cause confusion or even be a hindrance to LIS scholars in the selection and implementation of methods for research projects. Likewise, there are implications for LIS education in research methods. The present study attempts to examine those variations and suggest some measures for handling them.

2. Problem statement

There is apparently little consensus as to what constitutes a research method and how methods should be categorized. Determining the

---

* Corresponding author.
E-mail addresses: hchu@liu.edu (H. Chu), keqing@nju.edu.cn (Q. Ke).

actual connotation of the term *research method* would help researchers differentiate research methods from other terms (e.g., research designs, research methodologies) often seen in research publications. Scholars studying research methods usually develop their own lists by adopting various categorization criteria. Typically, no two inventories are identical unless a later study shares the research method categories formed in an earlier investigation. It may be feasible to choose one criterion for categorizing all research methods so that a uniform list of research methods can be created. Additionally, research methods are traditionally labeled as qualitative or quantitative to conform to the qualitative and quantitative research paradigms that have received much attention in the scholarly community. Such a division may be reasonable, but it also may not be able to withstand scrutiny.

LIS scholars now use a greater number and wider variety of research methods in their inquiries than they did before (Chu, 2015; Park, 2004). Performing a systematic examination of research methods applied in the LIS field will assist LIS researchers in understanding research methods. It would help researchers select appropriate methods when conducting scholarly efforts. It might also enable LIS educators to determine which research methods should be taught in degree programs, especially at the doctoral level.

The current study focuses exclusively on research methods in the field of LIS and addresses three research questions:

1) What constitutes a research method?
2) Which criterion is appropriate for categorizing and naming research methods?
3) Can research methods be classified exclusively as quantitative or qualitative?

3. Literature review

Studies of the research dimension of scholarly publications cover many variables in addition to research method, including author affiliation, research topic, and the relationship between research topic and method. To a large extent, some of the variables belong to the domain of bibliometrics and scientometrics, where key authors, core publications, top research topics, and similar variables are examined (Peritz, 1977). This study concentrated solely on the research method component.

Studies on research methods have typically been conducted through content analyses of a set of research publications, somewhere between 100 and several hundred, from selected journal titles. The time span involved usually covers several years either consecutively (e.g., Hildreth & Aytac, 2007) or selectively (e.g., Tuomaala, Järvelin, & Vakkari, 2014). Occasionally, non-journals have been chosen as data sources, including textbooks (Bernhard, 1993) and dissertations (Blake, 1994). Some studies focus on a single journal title (Luo & McKinney, 2015; Ngulube, 2015) while others cover several (Chu, 2015; Greifeneder, 2014) or a few dozen (Peritz, 1977; Tuomaala et al., 2014). Turcios, Agarwal, and Watkins (2014) examined 105 titles, but included only the latest issue of each title in the chosen time period in their study.

Studies of this nature have not only been done in the broadly defined discipline of LIS, but also in specific areas such as information behavior (Greifeneder, 2014; Julien, Pecoskie, & Reed, 2011), knowledge management (Ngulube, 2015), technical services (Gelber, 2013), information systems (Palvia, Mao, Salam, & Soliman, 2003), and health informatics (Dimitroff, 1992).

3.1. Research methods and associated concepts

Different scholars have different understandings and interpretations of what constitutes a research method. Peritz (1977), in one of the early studies on the topic, identified 11 research methodologies, including theoretical-analytic, information system design, and surveys on the

public, without grouping them by any subcategory. Research methodology in Hildreth and Aytac (2007), however, was defined as containing research type (i.e., descriptive, exploratory, explanatory, and evaluative), data collection methods (e.g., survey questionnaire, survey interview) and data analysis approaches (e.g., quantitative, qualitative). Research methodology (or methodologies) was taken to mean research methods in Peritz (1977) as well as in Hildreth and Aytac (2007). Likewise, Palvia et al. (2003), researchers in information systems, treated research methodology as a synonym for research method.

From the perspective of Järvelin and Vakkari (1990) research methods consist of research strategy (e.g., empirical, conceptual), data collection method (e.g., interview, observation, questionnaire), type of analysis (e.g., qualitative, quantitative), and type of investigation (e.g., empirical, descriptive, comparative, conceptual). The same classification scheme was followed in Kumpulainen (1991) as well as Hider and Pymm (2008). Almost 15 years after the Järvelin and Vakkari (1990) study, a slightly modified classification scheme was applied in Tuomaala et al. (2014) where, for example, IR experiment was added as a data collection method. Redundancy occurred among the four specified facets of research methods in these reports. For instance, citation analysis was listed both as a research strategy and data collection method. The same could be said about experiment and IR experiment, found respectively under research strategy and data collection method. Other identical pairs in dimensions relating to research methods in the classification scheme included qualitative method in research strategy and type of analysis, and empirical or conceptual in both research strategy and type of investigation. A noticeable degree of redundancy was also observed between research strategy and data collection method, as well as between research strategy and type of investigation. Research methods in the studies by Järvelin, Vakkari, and associates had broad connotations that encompassed research strategy, data collection method, type of analysis, and type of investigation.

Luo and McKinney (2015) considered research design (e.g., time dimension, research framework/paradigm), research model (e.g., platform market model), and research theories (e.g., sense of community theory) as separate elements. On the other hand, Ngulube (2015) regarded research methods and techniques as being synonymous; research approach and design (e.g., interview, survey), research methodology (i.e., quantitative, qualitative, mixed), and research paradigm (e.g., positivism, pluralism) were among the terms chosen for examining research. Taking a different approach, Feehan, Gragg, Havener, and Kester (1987) focused on research methods and analytical methods, and Gelber (2013) and Greifeneder (2014) adopted a similar practice.

Data collection techniques and data analysis techniques are the two components present in most, if not all, studies on research methods. All other terms were employed either as a synonym of research method (e.g., research strategy in Järvelin & Vakkari, 1990) or to represent dimensions other than research methods (e.g., research paradigm).

3.2. Categorization of research methods

Multiple categorizing conventions have been applied to research methods. Data collection technique, data analysis technique, research paradigm, research design, and more have all been used as criteria in categorizing research methods. Usually, more than one criterion has been selected in creating a taxonomy or list of research methods.

Peritz (1977) identified 11 research methods used in a selected set of LIS documents: bibliometric and similar studies, comparative studies, content analysis, descriptive bibliography, historical methodologies, information system design, secondary analysis, surveys on the public, surveys or experiments on libraries and others, theoretical-analytic, and other and multiple as one category for studies whose methods did not fit into one of the existing categories (p. 49). As Peritz (1977) is one of the early studies on the topic, her list of research method categories varies from that of more recent studies (Järvelin & Vakkari, 1990;

Turcios et al., 2014). Some of her research methods were named after data collection techniques (e.g., content analysis, surveys on the public) whereas others were based on research target (e.g., descriptive bibliography, information system design) and data analysis technique (e.g., comparative studies). Peritz uniquely divided surveys into two categories: surveys on the public and surveys or experiments on libraries and other settings.

About a decade after the Peritz (1977), Feehan et al. (1987) produced another list of 11 research methods: bibliometrics, content analysis, Delphi method, experimental, historical, observation and description, operations research, secondary analysis, survey, multiple, and other. Most of the research methods on the list were derived from data collection techniques (e.g., bibliometrics, Delphi method), although operations research is more a technique for data analysis. Multiple methods became a separate category in similar studies before researchers began counting each research method individually (Chu, 2015) or as primary and secondary (Palvia et al., 2003). Both Dimitroff (1992) and Gore, Nordberg, Palmer, and Piorun (2009) adopted the same research methods taxonomy by Feehan et al. (1987) in examining research publications of health informatics.

As noted earlier, the study by Järvelin and Vakkari (1990) had a significant impact on research of a similar nature, as their classification scheme was adopted in Kumpulainen (1991), Hider and Pymm (2008), and Tuomaala et al. (2014). Some components of the research method taxonomy Järvelin and Vakkari (1990) developed can be observed in other studies (Hildreth & Aytac, 2007) and their taxonomy is regularly referenced in related publications. Table 1 displays the lists of research strategy and data collection methods developed by Järvelin and Vakkari (1990).

According to Järvelin and Vakkari (1990), "research strategy is an overall approach to the study within which the decisions concerning data collection and the type of analysis are made" (p. 399). In this context, research strategy seems to determine research method selection. In Table 1, the empirical research strategy category bears a strong resemblance to the data collection methods shown at the right side of the same table. However, the former comprises methods other than data collection techniques. For example, case research method, more commonly known as case study, implies a small number of cases or sampling units, as opposed to a sizeable sample or an entire population, are studied in the research. Any data collection technique can theoretically be selected for conducting a case study. Also in Table 1, evaluation method refers to the research objective being used for evaluation. Similarly, qualitative method indicates that data collected in a study are analyzed qualitatively. The results in Table 1 were obtained by applying multiple criteria to categorize research methods.

In the list of data collection methods in Table 1, one additional technique, IR experiment, was introduced in Tuomaala et al. (2014). Questionnaire and interview have been grouped as one category because both are considered to be synonymous with survey. The "not applicable" category accounted for 43% of all the research publications coded by Järvelin and Vakkari (1990) and 24% coded in Tuomaala et al. (2014).

Unlike many researchers, Hildreth and Aytac (2007) did not set up research methods as a variable in their study. Instead, they recorded the following data collection methods: bibliometric and citation analysis, case study, computer log analysis, content analysis, Delphi study, experiment, observation, semi-structured interview, survey interview, survey questionnaire, and others. Case study, as explained before, concerns only the number of sampling units chosen and has no direct relation to data collection method. The authors also specifically placed surveys into two categories: survey interview and survey questionnaire. Semi-structured interview is listed as a data collection method separate from the survey interview, which might serve as a synonym for structured interview in Hildreth and Aytac (2007).

Additional taxonomies of research methods can be found in other studies (Bernhard, 1993; Blake, 1994; Turcios et al., 2014; Williams & Winston, 2003). Usability was categorized as a research method in Turcios et al. (2014). Usability, like evaluation method in Järvelin and Vakkari's (1990), is simply a research objective; other techniques ought to be used for collecting data in usability studies.

Rather than using research publications as source data, which appears to be the norm in the majority of related studies, Park (2004) compared LIS curricula for research methods in Korean and U.S. universities, showing that action research, bibliometrics, case study, comparative study, content analysis, Delphi study, desk research or literature review, ethnography, evaluative research, experiment, field study, focus groups, historical method, information system design, interview, observation, and survey or questionnaire were covered in those courses. This 17-item list of research methods is the longest one among all those reviewed. Some of the research methods, such as field study and focus groups, did not appear in other studies, while case study, comparative study, evaluative research, and information system design were not categorized according to data collection technique. In addition, desk research or literature review is considered a step in the research process, rather than a technique for data collection.

Most studies fall into the realm of LIS, though information systems is a related domain in which studies on research methods are published. Palvia et al. (2003) came up with 13 research methods used in management information systems research. Another method, content analysis, was added later to the list (Palvia et al., 2004). The taxonomy of 14 research methods, shown in the left column of Table 2, was applied in Palvia, Pinjani, and Sibley (2007). Avison, Dwivedi, Fitzgerald, and

Table 1
Research strategies and data collection methods in Järvelin and Vakkari (1990).

Research strategy	Data collection method
Conceptual research	Citation analysis
Concept analysis	Content analysis
Verbal argumentation or critique	Historical source analysis
Empirical research	Observation
Case or action research method	Other methods of collecting
Citation analysis	Questionnaire, interview
Content or protocol analysis	Several methods of collecting
Evaluation method	Think aloud
Experiment	Use of data collected earlier
Historical method	Not applicable
Other bibliometric method	
Qualitative method	
Survey method	
Other empirical method	
Literature review	
Mathematical/logical method	
System and software analysis and design	

Table 2
Research methods categorized in two studies.

Palvia et al. (2007)	Avison et al. (2008)
Case study	Action research
Content analysis	Case study
Field experiment	Content analysis
Field study	Ethnography
Frameworks and conceptual models	Field experiment
Interview	Grounded theory
Laboratory experiment	Interview
Library research	Laboratory experiment
Literature analysis	Library research/literature analysis/ frameworks/conceptual modeling
Mathematical model	Mathematical model
Qualitative research	Secondary analysis
Secondary data	Speculation/commentary
Speculation/commentary	Survey
Survey	Multi-method
	Others

Powell (2008) adapted this list of research methods in their study of information systems. The latter is displayed in the right column of Table 2.

Case study, library research, literature analysis, and qualitative research, from the list by Palvia et al. (2007), do not suggest any data collection techniques and cannot be regarded as research methods. According to those authors' definitions, library research and literature analysis are synonymous, although they were listed separately. Palvia and colleagues subdivided the category of experiment into field experiment and laboratory experiment in order to better reflect the characteristics of each method. A more suitable term for the secondary data category might be secondary analysis; data alone cannot be a technique for gathering data.

Although Avison et al. (2008) adapted their list of research methods from Palvia et al. (2007), the modified list contained unique items that represented either additional research methods, such as action research, or research paradigm, such as grounded theory. The multi-method and others categories commonly appear in many research methods taxonomies. The former is a category for those studies that use more than one method, while the latter includes any method that does not fit into an existing category. In comparison with related studies in LIS, research in information systems tends to choose conceptual modeling or mathematical modeling as a method. Even though conceptual or mathematical modeling is used more for data analysis, this method is mostly absent from the field of LIS.

Collecting data from three journals spanning information systems and health informatics, Davies (2012) developed the following list of data collection techniques: archive of e-mails, electronic medical records (EMRs), experiments, focus groups, freely available data, interviews, logs of user activity, observation, questionnaires, secondary data based on Eldredge (2004), Palvia et al. (2003) and other related research. This list is distinctive for its emphasis being placed solely on data collection techniques, along with some types of data sources, such as archive of e-mails. All the data sources on the list (i.e., archive of e-mails, EMRs, freely available data, and secondary data) could be used for content analysis, although that data collection technique was not included on the list.

Despite the different practices in categorizing research methods among the studies reviewed above, one theme clearly emerges: research methods are usually categorized by data collection technique. Other criteria, such as research objective and data analysis technique, may not be selected either individually or jointly for categorizing research methods.

3.3. Quantitative or qualitative research methods?

In recent decades, a growing interest in qualitative research has developed in the scholarly world. However, qualitative research has not been defined and a determination of whether research methods can be categorized as qualitative or quantitative has not been made. Fidel (1993) conducted an extensive review of qualitative research on information retrieval by summarizing its characteristics: open, holistic, flexible, noncontrolling, and case oriented. Fidel (1993) also determined that there was no agree-upon definition for the concept of qualitative research.

Researchers often categorize data analysis techniques as quantitative, qualitative, or other. Such categorizations can be found in Feehan et al. (1987), Hildreth and Aytac (2007), Järvelin and Vakkari (1990), as well as studies that were modeled after theirs. Generally speaking, data analyses that involve statistics are labeled as quantitative, while those without statistical analysis are marked as either qualitative or non-quantitative (Gore et al., 2009).

Previous studies frequently categorized research methods, comprising both data collection and analysis techniques, as qualitative or quantitative. This tradition was well documented in Powell (1999) when he explored trends in the use of research methods in LIS and other

social science disciplines. For example, ethnography, interview, and historical method were commonly considered qualitative methods, while experiment and questionnaire were usually placed in the category of quantitative methods. After reporting that research choosing experiments and modeling as research methods was increasing, Blake (1994) concluded that the assumption of equating quantitative methods and the scientific method should be re-examined. The author also indicated that "newer qualitative methods can play a significant role" in LIS research (p. 38). Hider and Pymm (2008) observed in their study that qualitative research, which was often conducted through interviews, gained a modest rise. They further commented that "an increase in the use of more sophisticated qualitative research methods has been balanced by the decrease in historical research and by an increase in experimentation" (p. 112). Interview and historical method in Hider and Pymm's study were labeled as qualitative research methods. In a more recent research project by Turcios et al. (2014), interview was again defined as a qualitative research method, based on the definition from Beck and Manuel (2008). Greifeneder (2014) likewise denoted that qualitative methods, including interviews, content analysis, observation, and focus groups, still dominated information behavior research.

The present study conducts a content analysis of related research and documents from three major LIS journals published between 2001 and 2010 to explore the classification and naming of research methods adopted in LIS studies, with particular attention to finding out if it is suitable to categorize research methods as qualitative and quantitative.

4. Data collection and analysis

Research articles published between 2001 and 2010 were obtained from *Journal of Documentation* (JDoc), *Journal of the American Society for Information Science & Technology*[1] (JASIS&T), and *Library and Information Science Research* (LISR). Editorials, literature reviews, book reviews, letters to the editor, and any other non-research articles were excluded in the data collection.

Journals were chosen as data sources for this study based on their status as core research journals in LIS. They have also been selected by previous studies on research methods (Fidel, 2008; Järvelin & Vakkari, 1990).

The data collection yielded 1981 research articles from the three chosen journals, a number higher than that recorded in any related studies. Table 3 details the frequency distribution of research articles by journal.

A coding schema of research methods used in LIS was developed (Table 4) after coding all the research articles from JDoc and LISR that were selected for this study. The resulting schema was then revised by coding research methods reported in all the JASIS&T articles in two time periods: 2001 to 2002 and 2009 to 2010. The grounded theory approach (Glaser & Strauss, 1967) was used to create the coding schema; the schema development was grounded on data gathered from the selected research articles rather than using any existing categorization. The schema development and the coding process were intertwined and iterative. The abstract and methodology section of each article were examined to see what data collection techniques were applied in the research reported. If necessary, other sections of the article were consulted in the coding process. The identified data collection techniques were all recorded and eventually grouped into categories that became individual research methods listed in the coding schema (Table 4). Further elaboration on the coding schema development is provided in the next section.

Coded results by two coders for a randomly selected sample of 30 articles, 10 from each of the three journals, were compared for

---

[1] ASIS&T changed its name from American Society for Information Science & Technology to Association for Information Science & Technology in 2012.

Table 3
Frequency distribution of research articles by journal 2001–2010.

JDoc	JASIS&T	LISR	Total
367	1373	241	1981

Table 4
Coding schema for research methods.

Bibliometrics (including citation analysis, informetrics, & scientometrics)
Content analysis (including discourse analysis, & secondary analysis)
Delphi study
Ethnography/field study
Experiment
Focus groups
Historical method
Interview
Observation
Questionnaire (including index, inventory, scale, & test)
Research diary/journal
Theoretical approach (e.g., conceptual analysis, modeling, & theory building)
Think aloud protocol
Transaction log analysis
Webometrics (including link analysis, cybermetrics, & altmetrics)
Other methods (e.g., action research, card sorting, information horizon)

consistency. The intercoder agreement rate was 86.7%, exceeding the acceptable-to-most rate of 80% (Neuendorf, 2002, p. 143). This intercoder agreement rate also indicates the reliability of both the coding schema and coding process. Where different coding results were obtained, the two coders discussed and reached a consensus. This constituted the first phase of data collection. In the second phase, the authors coded the remaining six years (i.e., 2003–2008) of JASIS&T publications by using the same coding schema and following the same coding procedure. The intercoder agreement rate for all the coded articles between the two was 91.7%, which surpasses the acceptable-to-all rate of 90% (Neuendorf, 2002, p. 143).

If a study used more than one method, each method was recorded in the order in which it was reported in the article. If a study adopted the true experimental design in the form of experimental versus control groups with a pre-test, treatment, and post-test, it usually would employ at least another research method, such as a questionnaire or interview, for performing the pre-test and post-test. That study would then be coded once as experiment and again for the other research methods, according to what was employed for data collection. In contrast, research using quasi- or pre-experiments was simply coded as experiment, without additional methods given the nature of such experiments. No weights were assigned to any of the multiple methods applied in a single study because this would introduce an element of subjectivity to the coding process. The collected data were then analyzed quantitatively and qualitatively.

5. Findings

5.1. Coding schema of research methods: some decision points

Few of the many lists of research methods in LIS were developed according to a single criterion. Using multiple criteria in classifying research methods is common practice. In order to follow the two essential principles of being collectively exhaustive and mutually exclusive in any categorization or classification efforts, a single criterion should be employed when categorizing research methods.

Additionally, as shown in the literature review and data collection, research methods comprise data collection techniques and data analysis techniques. All other concepts are not guaranteed to be considered in every research publication, and individually such concepts go beyond the boundary of research methods. For instance, a research paradigm,

such as naturalism, is more meaningful at the conceptual level than when directly linked to a specific data collection technique. Thus, the criterion for categorizing and naming research methods is chosen between data collection technique and data analysis technique. It is up to the researcher to determine which one is more appropriate.

When explaining the etymology of the term "method", Glazier (2010) indicates that method is the pursuit after some end or a procedure employed to attain a certain end. In this case, the end is the data to be collected and the method is the means (p. 32). Experiment, interview, observation, and questionnaire are some means researchers use to achieve the end of data collection. The coded data in the present study uniformly show that, for instance, scholars use questionnaires for data collection in questionnaire research. Investigators conduct experiments to gather data in experimental research. Therefore, data collection technique is selected for categorizing and naming research methods listed in the coding schema (Table 4). Data analysis technique should be reserved to distinguish between qualitative research and quantitative research.

5.2. Research methods in the coding schema

More than 15 research methods were identified and named after corresponding data collection techniques (Table 5). Because each method in any multi-method study was counted once in the tally, the total number of research methods in each column of Table 5 exceeds the number of research articles from each journal. All the research methods in Table 5 are described below and presented alphabetically by their names for easy reading.

5.2.1. Bibliometrics

Bibliometrics is a method used for collecting publication and citation data. It is commonly applied in LIS research and is ranked the second most frequently reported method in JASIS&T. In the present study, bibliometrics also includes citation analysis, informetrics, and scientometrics because they all share the same type of data: publication and citation data. It is the research focus that differentiates one from the other. When the research focus is on citations, it is called citation analysis. When the research focus is on information, it is called informetrics. When the research focus is on sciences, it is called scientometrics. This method is similar to content analysis if the data collected comprise bylines, acknowledgments, and other similar components of

Table 5
Frequency distribution of research methods used in three all LIS journals.

Research method	JASIS&T (N = 1373)	JDoc (N = 367)	LISR (N = 241)	Total
Experiment	482	49	21	552
Bibliometrics	270	31	14	315
Questionnaire	247	51	68	366
Content analysis	215	52	73	340
Theoretical approach	195	141	36	372
Interview	145	49	48	242
Transaction log analysis	86	18	9	113
Observation	63	11	15	89
Webometrics	57	9	6	72
Think aloud protocol	35	5	3	43
Focus groups	29	6	9	44
Ethnography/field study	16	3	2	21
Research diary/journal	13	5	2	20
Delphi study	9	0	2	11
Historical method	8	7	2	17
Other	10	0	0	10
Total	1880	437	310	2627

written publications.

5.2.2. Content analysis

Content analysis refers to collecting data by conducting systematic examination of texts or other passages in the contexts of their use (Krippendorff, 2004, p. 18). This study considers content analysis as a data collection technique, although it can also be used for data analysis. When it is adopted as a data collection technique, researchers analyze the chosen data source in order to gather the necessary data for a research project. There are two things to point out regarding the word "analysis". First, analysis includes abstraction, comparison, synthesis, and other analytical techniques applied in the process. For this reason, comparative study is not listed as a research method separately from content analysis. Second, analysis in this and other research methods, such as citation analysis and transaction log analysis, means that analysis is performed for data collection purposes.

Content analysis can be further divided into two types: manifest and latent. Manifest content analysis denotes that what needs to be analyzed is physically present, observable, and countable, which is easier than latent content analysis. Analyzing what research methods are used in a scholarly publication is an example of manifest content analysis. Latent content analysis implies that what needs to be analyzed is hidden (underlying), conceptual, unobservable, and uncountable. An example would be finding out what research paradigm or theoretical origin is applied in a research publication. Latent content analysis, when contrasted with the manifest counterpart, is more difficult.

In the present research, content analysis also includes discourse analysis and secondary analysis, since these can be employed for data collection by examining some kind of data source. The data source defines the specific type of analysis. For example, a research method is called discourse analysis if the target source is discourse data, such as interview transcripts. Similarly, a research method is called secondary analysis if the target source is secondary data, namely data collected previously for other purposes. Census data are a common example of secondary data. Meta-analysis is a type of secondary analysis or content analysis because it is used for gathering data, usually statistical in nature, from individual studies to achieve research objectives. Content analysis is widely used in LIS; it ranked first, second, and fourth respectively in LISR, JDoc, and JASIS&T in terms of usage frequency (Table 5).

5.2.3. Delphi study

The Delphi method is generally used for collecting data with a questionnaire from a group of experts to address a research problem in order to reach consensus and make forecasts via several rounds of exchanges. Unlike some other research methods, including content analysis and theoretical approach, a Delphi study can be easily identified in the coding process of this research because of its distinctive features, such as the selection of experts and the conducting of several rounds of data collection using a questionnaire. Strictly speaking, it is a contingent research method that relies upon questionnaires and cannot be used alone. The Delphi method, although well known, appears only nine times in JASIS&T and twice in JDoc.

5.2.4. Ethnography and field study

Ethnography and field study share many characteristics in data collection. Both can be applied when collecting data using multiple techniques, such as observation and interview, in a natural setting where participants live or work. Therefore, they are grouped as one type of research method in this study. In addition, there is no fixed, specific set of data collection techniques for either ethnography or field study. Instead, researchers select individual data collection techniques according to their research goal. In the three LIS journals explored in this study, a total of 21 studies chose this research method, compared to none in earlier investigations of a similar nature (Feehan et al., 1987; Järvelin & Vakkari, 1990; Peritz, 1977).

5.2.5. Experiment

Experiment is an established method for collecting data by following a procedure to test what is studied in either a laboratory or field setting, corresponding to laboratory experiments and field experiments described in Palvia et al.'s (2007) list of research methods. Experiment is the most often used method (a frequency of 482) in the 1373 JASIS&T publications. However, experiments in JASIS&T, JDoc, and LISR usually differed from the experimental designs Campbell and Stanley (1966) depicted because such experiments were conducted mainly for evaluating new procedures (e.g., key-phrase extraction), algorithms (e.g., search result ranking), or systems (e.g., digital libraries) reported in the publications. In LIS, experiments rarely take the classic design of experimental and control groups with pre-test, treatment, and post-test. Rather, experiments are normally performed in a laboratory or simulated environment with one or more of the experiment essentials and therefore fall under the quasi- or pre-experiment category. In future studies, experiments should be further broken down into classic and non-classic designs rather than considered as a single research method. This would better represent the range of experiment as a research method in LIS.

In addition, experiment is a method often employed in conjunction with other data collection techniques. Typical implementations include the use of questionnaire or interview for pre-test and post-test, observation for collecting behavioral data, and think aloud protocol for gathering cognitive data during the experiment. Experiment is therefore a meta-method.

5.2.6. Focus groups

As a research method, focus groups refer to data collection via discussion of a research problem between a moderator and a group of participants. Several groups are usually invited to participate in one study, hence the plural form being used to refer to the method. The focus group method is used a total of 44 times in the 1981 articles from the three journals, close to the lower end of usage frequency (Table 5). Focus groups are sometimes characterized as focus-group interviews (Kim & Kim, 2008) or group interviews (Agosto & Hughes-Hassell, 2006). However, the emphasis of focus groups is not placed on question and answer, as is the case in interviews. Instead, the emphasis is placed on discussion and interaction among group members.

5.2.7. Historical method

Historical method played a dominant role in LIS research until the 1980s (Feehan et al., 1987; Järvelin & Vakkari, 1990). Historical method refers to collecting data by examining, synthesizing, summarizing, and interpreting existing published and unpublished materials related to a historical research problem. Historical method bears some similarity to content analysis because both methods analyze the content of materials for data collection purposes. Historical method differs from content analysis because it deals exclusively with problems of a historical nature.

5.2.8. Interview

Interview is a data collection technique where individual participants are asked questions relating to a research problem. There are three kinds of interviews, differentiated by how interview questions are prepared and whether probe or follow-up questions are allowed. If the researcher has a prepared list of questions for the interview, it is called structured interview. Structured interview is mostly analogous to questionnaire. If the researcher does not use a prepared list of questions and formulates specific interview questions on site, it is called unstructured interview. If the researcher asks some questions from the prepared list, but also uses some probe or follow-up questions, it is called semi-structured interview. Interview is respectively ranked the third, fifth, and sixth most frequently used research method in LISR, JDoc, and JASIS&T. Although this study does not differentiate interview method by type, semi-structured interview is the most frequently

adopted because of its flexibility in application.

5.2.9. Observation

Observation is a method for gathering data via carefully and attentively watching and making notes on the subject being studied. All five senses of the observer need to be used in data collection (Baker, 2006). Observation can be made in a lab or in the field. Common subcategories of observation include obtrusive or unobtrusive and participant or nonparticipant. Observation as a stand-alone method is not regularly employed, totaling 89 times of usage in the 1981 research articles examined in this study.

As noted earlier, observation is often performed as part of meta-methods, such as experiment and field study. In the case of classic experiments, observation is a must-have technique for collecting behavior data before and after the treatment is administered. In order to obtain data for comparing the before-after and old-new differences, some form of observation is necessary in non-classic experiments. Ethnography and field study often use observation as one of multiple data collection techniques. Consequently, observation is often discussed in the context of ethnography and field study (Baker, 2006; Fox, 1998; Spradley, 1980). In addition, observation is also used when applying such data collection techniques as interview and focus groups, though observation would not be explicitly specified as a separate method in those studies. For example, the interviewer would closely observe any non-verbal language of the interviewee during the interview process.

5.2.10. Questionnaire

Questionnaire, often known as survey, is a technique for data collection using a predefined list of questions. A questionnaire can comprise both closed-ended and open-ended questions, although in most cases the former make up the majority or the only type of questions in the data collection instrument. Questionnaire was reportedly the most used research method in many previous LIS studies (Blake, 1994; Turcios et al., 2014). Questionnaire is the second most used research method in LISR and the third most commonly used research method in both JDoc and JASIS&T (Table 5). Structured interview is considered one form of survey. It is perhaps for this reason that some researchers (Järvelin & Vakkari, 1990) group questionnaire and interview as one type of research method: survey. Certain scales (e.g., the Library Anxiety Scale), indexes, inventories, and tests (e.g., personality test) can also be regarded as a type of questionnaire and are therefore placed in this category of research method in this study. Furthermore, questionnaire is regularly used for pre-test and post-test when conducting an experiment. Questionnaire is also a prerequisite technique for carrying out the Delphi study, which is a contingent research method. In these two cases, questionnaire may not be considered a separate data collection technique in the selected research publications this study examined.

5.2.11. Research diary or journal

Research diary or journal is a technique used to gather data about events, activities, thoughts, reflections, or other aspects by an individual who keeps the diary over a period of time. In recent years, information seeking behavior has become a common topic in the LIS field. Information seeking behavior sometimes relies on subjects keeping a research diary for data collection. A research diary can be structured (e.g., using a form), semi-structured, or unstructured (i.e., open-ended with no particular format requirement). Compared with other research methods listed in Table 5, research diary is employed less often, with a total usage frequency of 20 in this study.

5.2.12. Theoretical approach

Theoretical approach, as a research method, is a technique for gathering data through conceptual analysis, theoretical examination, or similar activities. Although few studies on research methods choose the same term for this technique, Järvelin and Vakkari (1990) identify a research strategy of conceptual analysis in their study, while Bernhard (1993) enumerates theory development in her taxonomy of research methods. In the current study, in terms of usage frequency, theoretical approach is the top used research method in JDoc, the fourth in LISR, and the fifth in JASIS&T.

Theoretical approach is somewhat similar to content analysis, especially latent content analysis. The distinctive feature of this approach lies in its focus on "theoretical" in that researchers perform conceptual or theoretical analysis according to existing theories, models, and the like. In some studies that adopt the theoretical approach, the ultimate objective is to develop a theory or model in a respective domain. Notably, the theoretical approach is not considered a review because the latter only does evaluation without any further conceptual analysis, modeling, or theory building.

5.2.13. Think aloud protocol

Think aloud protocol is a research method intended to collect data about participants' cognitive activities via the verbal reports of their thoughts, called think alouds, while taking part in an experiment or performing some task (Ericsson & Simon, 1980). This method originated in cognitive psychology, but has been adopted in recent decades for research in LIS, especially in information seeking. Like the Delphi method, think aloud protocol cannot be used alone. It is instead contingent on experiments of certain kinds. This method is used a total of 43 times for data collection in the three journals.

5.2.14. Transaction log analysis

Transaction log analysis, as a research method, gains momentum when computerized systems are used for information processing and access. It refers to researchers gathering data by analyzing transaction logs that are automatically captured at either the server or client side. Transaction logs that interest LIS researchers include search logs (e.g., search terms entered) and system usage data (e.g., abstracts viewed, articles downloaded). Captured screens can sometimes be grouped with transaction logs since the screen displays interaction data between the user and system. As shown in Table 5, due to the development of data capturing applications, transaction log analysis increased from being a little used research method to one with a moderate usage frequency of 113 times.

5.2.15. Webometrics

Webometrics is defined as bibliometrics in the web environment, where webpages and websites are generally regarded as publications; with inlinks (i.e., links a webpage or site receives) being considered as citations and outlinks (i.e., links a webpage or site makes to others) being considered as references. The web has its own citation or link indexes in the form of commercial search engines, ready for researchers to explore (Thelwall, 2008). Webometrics became a research method for collecting data from the web via a search engine in the late 1990s and early 2000s. In the present study, there were 72 occurrences of the webometric method (Table 5).

As indicated in Table 4, webometrics in the context of this study also includes link analysis, cybermetrics, and altmetrics. A study uses the link analysis method if it collects only link data. The Internet, of which the web is a part, is often referred to as cyberspace. In that sense, cybermetrics encompasses webometrics, but now webometrics has superseded it as the preferred term. Other metric data (e.g., article downloads, views, mentions) are increasingly available from academic social media (e.g., academia.edu, Mendeley), digital libraries, and other similar platforms. Altmetrics, short for alternative metrics, emerged in recent years as a research method for collecting such data, differentiated from traditional bibliometric or webometric data. Although the current research places altmetrics in the category of webometrics, future taxonomy of research methods may list altmetrics separately from webometrics due to a growing number of studies adopting altmetrics as a research method.

Table 6
Frequency distribution of other research methods.

Research method	Frequency
Action research	2
Card sorting	4
Drawing	2
Information horizon	1
Photo survey	1

5.2.16. Other methods

In addition to the 15 research methods described above, there are five data collection techniques reported in 10 of the 1373 JASIS&T research articles this study examines. Because of their low usage frequencies (Table 6), these methods are merged into one category called other methods.

- Action research can be considered similar to ethnography or field study in that it also uses multiple data collection techniques in a real setting. Nevertheless, action research always intends to solve an immediate problem or to produce guidelines for best practice. It relies on techniques for collecting data that would actuate changes or actions in the target setting or environment. Such techniques include participant observation, interview, and focus groups (Berg, 2009, p. 258).
- Card sorting is a technique for collecting data by asking participants to put cards of assorted entities (e.g., concepts, website headings) into groups. Through this technique, the researcher can gather data about how participants categorize the given entities.
- Drawing, as a data collection technique, asks participants to sketch what they see, feel, think, and do. This technique is often used in conjunction with other research methods to help the researcher gather visual data.
- Information horizon, a technique used mainly in information seeking behavior research, aims to gather data from participants about their usage and ranking of individual information resources (e.g., colleagues, friends, Internet, library, personal collection). Each participant first draws a large circle as the information horizon and then places small circles on the large one, each representing one information source used in information seeking. Finally, the participant ranks those resources to indicate their preferences for each.
- The photo survey technique serves as the researcher's visual notebook during data collection. Photo survey researchers use a camera to photographically record the scenes and surroundings of their study targets. The photo survey is always supplemented by observation and other techniques to make up the complete research methodology.

There are more research methods, such as eye tracking, than presented above. As this study is grounded on the data gathered from the three LIS journals, any research method not reported in the 1981 publications is not considered.

5.3. What a research method is not

As demonstrated in Table 4 and according to all the findings reported so far, the following may not be considered research methods for this study's rationale:

- Case study: Although some prior publications list case study as a research method, this study finds that case study only implies a small number of cases or sampling units, typically one or several, as opposed to a sizeable sample or the entire population, are studied in the research. There is no indication about which research method or

data collection technique a case study may use. When using a case study, a researcher can choose any method that suits the study's purpose.
- Grounded theory: According to Bawden (2012), "grounded theory is, notoriously, not a research method in itself, but rather a general strategy" (p. 156). Grounded theory refers to a study being conducted without adopting an existing framework or theory, with the intention being to ground the study's work on the data being collected and analyzed. Typically, the appropriate methods for a given study are determined by the problem it explores, but not if the study uses the grounded theory approach. The grounded theory approach does not suggest any particular research method or data collection technique for a study.
- Library research: Also known as desk research, library research refers to a step or component, namely literature search, in the research process. Library research itself does not imply any research method or data collection technique. In all studies, researchers are expected to conduct a literature search in order to learn more about the history of their chosen research topic.
- Longitudinal study: This refers to research where temporal coverage expands over a period of time. Its counterpart is the cross-sectional study. The longitudinal study deals solely with the temporal scope or coverage of a study and provides no natural linkage to any research method. A longitudinal study can employ any technique for data collection.

In sum, data collection technique might be the only plausible criterion for naming and categorizing research methods. Other criteria are appropriate for categorizing research strategies or paradigms (e.g., grounded theory), research processes (e.g., library research), research types (e.g., sampling size, temporal scope), or data analysis techniques (e.g., quantitative, qualitative). For this reason, multiple methods are not selected as a type of research method in this study.

6. Discussion

Two distinctive themes emerge from this study. One theme is that data collection technique might be the most appropriate criterion for naming and categorizing research methods. The other theme demonstrates that research method cannot be labeled as purely qualitative or quantitative.

6.1. Naming and categorizing research methods by data collection technique

In many studies, multiple criteria have been applied for developing a list or taxonomy of research methods. The current study proposes that data collection technique might be the most appropriate criterion for naming and categorizing research methods.

First, categorizing research methods or developing a taxonomy for them is basically an exercise of classification and should thus follow the established principles that guide all such efforts: of being collectively exhaustive and mutually exclusive. This means that a single criterion should be employed in the categorization of research methods. If research methods were categorized according to more than one criterion, the end results would be neither mutually exclusive nor collectively exhaustive. Quite a few such examples were reviewed earlier in this study.

Second, determining what could be chosen as the criterion for categorizing research methods varies among studies. Some studies select criteria other than the data collection technique for categorization. Research methods comprise data collection techniques and data analysis techniques. Any criterion that is not part of research methods would not be a proper criterion for categorization purpose. It is also unsuitable to select data analysis technique as a criterion for categorizing research methods for reasons given below.

Third, except in the cases of content analysis and theoretical approach, data must be first collected before being analyzed.[2] The type of data collected dictates the kind of technique used for analysis purpose. This sequence indicates why data collection technique, rather than data analysis technique, is the most appropriate criterion for categorizing research methods.

6.2. No research method is entirely qualitative or quantitative

The data analysis technique, as one of the two components of research methods, is normally categorized as qualitative or quantitative at the top level. Based on the nature of data collected, qualitative and quantitative analysis techniques can each be further classified more specifically, a topic beyond the scope of this study.

One major reason why research methods cannot be categorized as qualitative and quantitative is that almost all the techniques (e.g., questionnaire, observation) are able to be used to collect both qualitative and quantitative data despite the fact that each may be oriented toward one of the two. For example, questionnaires can contain open-ended questions, which aim to gather qualitative data, though questionnaire is usually adopted for collecting quantitative data. Similarly, observation is typically used for qualitative data collection (e.g., how social network members interact with one other), but could be employed to gather quantitative data (e.g., number of contacts for each social network member). Likewise, an experiment can be used to collect both qualitative (e.g., observation notes) and quantitative (e.g., usability performance measures of an information system) data, though experiment is often considered a method for quantitative research in publications.

Whether qualitative or quantitative techniques should be used for data analysis in a study depends entirely on the type of data (i.e., qualitative or quantitative) being collected. When qualitative as well as quantitative data are collected, for instance via questionnaire, both qualitative and quantitative techniques could be employed for analyzing them. Placing questionnaire into the quantitative category only makes it unclear as to how the qualitative data gathered via open-ended questions should subsequently be qualitatively analyzed. It is therefore unsuitable to categorize and name research methods by data analysis technique. For the same reason, for example, questionnaire cannot be solely called a quantitative method or observation considered a purely qualitative one.

Plural methodology use appears to be trending in LIS research. Table 7 shows how many times each research method identified in the current study is used in multi-method studies, indicating both the frequency and corresponding order in which a particular method is reported in the data set. For example, in the case of JDoc, content analysis was chosen as a research method in a total of 52 studies, of which 37 listed content analysis as the first or only research method, 14 as the second, zero as the third (merely as a position holder when no study adopts content analysis as a third research method in a multi-method investigation), and one as the fourth. This is presented as $37 + 14 + 0 + 1$ after the total frequency in Table 7. In a multi-method study, some methods (e.g., questionnaire) are good for gathering quantitative data, while others (e.g., interview) seem suitable for collecting qualitative data. This demonstrates another reason why research methods should not be categorized as qualitative or quantitative.

As shown in Table 7, only three methods (i.e., ethnography, historical method, and webometrics) are not used in conjunction with

---

[2] This is true in the cases of content analysis and theoretical approach because data analysis is an integral part of the data collection process for both methods. When content analysis or theoretical approach is chosen for collecting data, analysis has to be performed in order to undertake the data collection task. Even though it is still legitimate to indicate that data collection technique is the criterion used for naming and categorizing content analysis and theoretical approach as research methods, the data analysis technique employed for collecting data is inseparable from the data collection technique in either case.

another method. Such cases only account for a small percentage of all the research publications considered. Many articles included in this study reported the use of multiple methods. This reinforces the need to use data analysis technique as a classification principle.

6.3. Applicability of research methods

Is there any prerequisite for the research methods explored in this study to be applied in LIS research? Table 8 presents a taxonomy of research methods by applicability in order to facilitate a better understanding of them. For example, some methods (e.g., questionnaire) can be used alone, whereas others (e.g., think aloud protocol) have to be employed in conjunction with another method.

Among the research methods examined, some can be regarded as super-methods. These include content analysis, which is used in almost all research to some degree. Some studies may exclusively focus on analyzing the content of data sources for data collection purpose, while other investigations perform content analysis as a supplemental method. Likewise, techniques like comparison are often used in the process of data collection. However, comparison is not listed as a separate technique since comparison, like summarization and abstraction, is one of the major techniques adopted in performing content analysis.

Meta-methods in Table 8 refer to those involving multiple techniques for data collection. In the classic sense, experiment is a pertinent example of meta-method. When experiment is chosen as the research method for a study, several individual techniques such as interview, observation, questionnaire, and think aloud protocol need to be used in various combinations according to the experimental study's purpose. In fact, only when multiple methods are simultaneously employed in a study can the experiment be conducted. Ethnography or field study is another example of meta-methods. Focus groups, interview, observation, and research diary are among the common tools ethnographers use.

The third category in the taxonomy of research methods concerns stand-alone methods, where each method can be used alone in a study if appropriate. Compared with other categories in Table 8, this one is the largest. Some of the research methods (e.g., bibliometrics, interview, questionnaire) are widely applied, while others (e.g., focus groups, research diary) are used less frequently.

As a group, contingent methods have to be used together with another method in order to be functional. Research participants, for instance, must conduct test searches if think aloud protocol is chosen for gathering data about their cognitive activities in the search process. Such test searches are one type of experiment and provide the basis for the participants to think aloud while searching. Otherwise, the participants would not be able to verbalize anything meaningful in relation to their search activities. The same is true with Delphi study, in which a questionnaire must be developed and used for data collection purpose.

The last class of research methods in Table 8 is called pseudo-methods. These methods cannot be used for data collection in research and, therefore, are not qualified as research methods. They only denote the scope of research. Case study, as indicated earlier, means that the research examines one or more cases (i.e., sampling units) rather than the entire population. Longitudinal study implies that a period of time (e.g., 2001–2010) is covered in the research. Cross-sectional study, on the other hand, is the opposite of longitudinal because it looks at data collected at one temporal point (e.g., 2001).

6.4. Further research

It might be useful to further break down the experiment category into classic and non-classic because most experiments in LIS research fit into the latter. Also, altmetrics might be listed as a separate method in future coding schema of research methods as more studies adopt this method in response to the emergence and rapid growth of social media and other similar platforms. Finally, the coding schema of research

Table 7

Frequency and order of research methods in the data set.

JASIS&T (N = 1373)		JDoc (N = 367)		LISR (N = 241	
Method	Freq (1st + 2nd + …)	Method	Freq (1st + 2nd + …)	Method	Freq (1st + 2nd + …)
Experiment	482 (418 + 45 + 15 + 4)	Theoretical approach	141 (133 + 8)	Content analysis	73 (61 + 10 + 1 + 0 + 1)
Bibliometrics	270 (258 + 11 + 0 + 1)	Content analysis	52 (37 + 14 + 0 + 1)	Questionnaire	68 (64 + 3 + 1)
Questionnaire	247 (139 + 78 + 16 + 14)	Questionnaire	51 (38 + 10 + 3)	Interview	48 (26 + 16 + 4 + 2)
Content analysis	215 (149 + 34 + 18 + 14)	Experiment	49 (45 + 2 + 2)	Experiment	21 (14 + 4 + 3)
Theoretical approach	195 (191 + 4)	Interview	49 (35 + 9 + 5)	Observation	15 (6 + 6 + 3)
Interview	145 (51 + 51 + 30 + 13)	Bibliometrics	31 (29 + 2)	Bibliometrics	14 (13 + 1)
Transaction log analysis	86 (45 + 15 + 17 + 9)	Transaction log analysis	18 (14 + 2 + 2)	Transaction log analysis	9 (8 + 1)
Observation	63 (15 + 26 + 17 + 5)	Theoretical approach	141 (133 + 8)	Focus groups	9 (5 + 3 + 0 + 1)
Webometrics	57 (46 + 10 + 1)	Observation	11 (6 + 4 + 1)	Webometrics	6
Think aloud protocol	35 (3 + 14 + 11 + 7)	Webometrics	9 (8 + 1)	Think aloud protocol	3 (0 + 1 + 2)
Focus groups	29 (7 + 8 + 10 + 4)	Historical method	7 (6 + 1)	Ethnography	2
Ethnography	16 (13 + 1 + 0 + 2)	Focus groups	6 (4 + 2)	Historical method	2
Research diary	13 (6 + 6 + 1)	Research diary	5 (1 + 3 + 0 + 1)	Delphi study	2 (1 + 0 + 0 + 1)
Delphi study	9 (6 + 1 + 0 + 2)	Think aloud protocol	5 (0 + 4 + 1)	Research diary	2 (0 + 2)
Historical method	8	Ethnography	3		
Card sorting	4 (3 + 0 + 1)				
Drawing	2 (0 + 1 + 1)				
Action research	2 (0 + 0 + 2)				
Information horizon	1 (0 + 1)				
Photo survey	1 (0 + 1)				

Table 8

Taxonomy of research methods in LIS by applicability.

Applicability	Method
Super-methods	Content analysis
Meta-methods	Experiment, ethnography/field study
Stand-alone methods	Bibliometrics, focus groups, historical method, interview, observation, questionnaire, research diary, theoretical approach, transaction log analysis, webometrics
Contingent methods	Delphi study, think aloud protocol
Pseudo-methods	Case study, longitudinal study, cross-sectional study

methods could be applied to data collected beyond the 2001–2010 time period from the three selected journals, as well as from other LIS journal titles.

7. Conclusion

Data collection and analysis techniques are the two major components of any research method. Research methods, however, should be categorized and named by data collection technique. For example, a study would be named as observation research if observation was used as a technique for data collection. Similarly, experimental research suggests experiment as the data collection technique. The type of data each technique collects determines whether qualitative or quantitative techniques should be used for analysis. Statistical or quantitative techniques (e.g., central tendency measures, significance tests) will be applied to analyze numeric or quantitative data. By contrast, qualitative techniques (e.g., qualitative coding, content analysis) are employed to analyze textual (e.g., words, phrases, passages, discourses) or qualitative data.

The coding schema of research methods developed in this study could shed light on categorization of research methods, and could lead to the common use of classifying research method by data collection technique rather than other criteria. Using the taxonomy of research methods by applicability (Table 8) would enable LIS researchers to approach each method by considering its suitability in exploring the problem at hand. This study is one of the many efforts to promote a better understanding of research methods and subsequently to help LIS scholars make more informed decisions about research method selection and implementation. The implications of the present study can extend to LIS research education, training, and advocacy. In addition, because research methods themselves are not discipline-specific, the findings of this research could also benefit researchers beyond the LIS field.

References

Agosto, D. E., & Hughes-Hassell, S. (2006). Toward a model of the everyday life information needs of urban teenagers, part 1: Theoretical model. *Journal of the Association for Information Science and Technology, 57*, 1394–1403.

Avison, D. E., Dwivedi, Y. K., Fitzgerald, G., & Powell, P. (2008). The beginnings of a new era: Time to reflect on 17 years of the ISJ. *Information Systems Journal, 18*(1), 5–21.

Baker, L. M. (2006). Observation: A complex research method. *Library Trends, 55*, 171–189.

Bawden, D. (2012). On the gaining of understanding syntheses, themes and information analysis. *Library and Information Research, 36*(112), 147–162.

Beck, S., & Manuel, K. (2008). *Practical research methods for librarians and information professionals.* New York, NY: Neal-Schuman.

Berg, B. L. (2009). *Qualitative research methods for the social sciences* (7th ed.). Boston, MA: Allyn and Bacon.

Bernhard, P. (1993). In search of research methods used in information science. *Canadian Journal of Information and Library Science, 18*(3), 1–35.

Blake, V. L. P. (1994). Since Shaughnessy: Research methods in library and information science dissertation, 1975–1989. *Collection Development, 19*(1/2), 1–42.

Campbell, D. T., & Stanley, J. C. (1966). *Experimental and quasi-experimental designs for research.* Chicago, IL: Rand McNally.

Chen, W., & Hirschheim, R. (2004). A paradigmatic and methodological examination of information systems research from 1991 to 2001. *Information Systems Journal, 14*(3), 197–235.

Chu, H. (2015). Research methods in library and information science: A content analysis. *Library & Information Science Research, 37*, 36–41.

Davies, K. (2012). Content analysis of research articles in information systems (LIS) journals. *Library and Information Research, 36*(112), 16–28.

Dimitroff, A. (1992). Research in health sciences library and information science: A quantitative study. *Bulletin of the Medical Library Association, 80*, 340–346.

Eldredge, J. D. (2004). Evidence-based librarianship: An overview. *Bulletin of the Medical Library Association, 88*, 289–302.

Ericsson, K. A., & Simon, H. A. (1980). Verbal reports as data. *Psychological Review, 87*(3), 215–251.

Feehan, P. E., Gragg, L. W., Havener, M. W., & Kester, D. D. (1987). Library and information science research: An analysis of the 1984 journal literature. *Library & Information Science Research, 9*, 173–185.

Fidel, R. (1993). Qualitative methods in information retrieval research. *Library & Information Science Research, 15*, 219–247.

Fidel, R. (2008). Are we there yet?: Mixed methods research in library and information science. *Library & Information Science Research, 30*, 265–272.

Fox, N. (1998). *How to use observations in a research project.* Sheffield, England: Trent Focus Group. Retrieved from http://www.webcitation.org/5ZndSmDde.

Gelber, N. (2013). Five years of empirical research in the area of technical services: An examination of selected peer-reviewed journals, 2007–2011. *Technical Services Quarterly, 30*, 166–186.

Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative*

research. Chicago, IL: Aldine.

Glazier, J. D. (2010). Domain assumptions of research. In L. S. Connaway, & R. R. Powell (Eds.). *Basic research methods for librarians* (pp. 28–43). (5th ed). Westport, CT: Libraries Unlimited.

Gore, S. A., Nordberg, J. M., Palmer, L. A., & Piorun, M. E. (2009). Trends in health sciences library and information science research: An analysis of research publications in the *Bulletin of the Medical Library Association* and *Journal of the Medical Library Association* from 1991 to 2007. *Journal of the Medical Library Association, 97*, 203–211.

Greifeneder, E. (2014). Trends in information behaviour research. *Information Research, 19*(4), Retrieved from http://www.informationr.net/ir/19-4/isic/isic13.html#. WfTjpxOPLRg.

Hider, P., & Pymm, B. (2008). Empirical research methods reported in high-profile LIS journal literature. *Library & Information Science Research, 30*, 108–114.

Hildreth, C. R., & Aytac, S. (2007). Recent library practitioner research: A methodological analysis and critique. *Journal of Education for Library & Information Science, 48*, 236–258.

Järvelin, K., & Vakkari, P. (1990). Content analysis of research articles in library and information science. *Library & Information Science Research, 12*, 395–421.

Julien, H., Pecoskie, J., & Reed, K. (2011). Trends in information behavior research, 1999–2008: A content analysis. *Library & Information Science Research, 33*, 19–24.

Kim, Y. H., & Kim, H. H. (2008). Development and validation of evaluation indicators for a consortium of institutional repositories: A case study of dCollection. *Journal of the American Society for Information Science and Technology, 59*, 1282–1294.

Krippendorff, K. (2004). *Content analysis: An introduction to its methodology* (2nd ed). Thousand Oaks, CA: Sage.

Kumpulainen, K. (1991). Library and information science research in 1975. *Libri, 41*(1), 59–76.

Luo, L., & McKinney, M. (2015). JAL in the past decade: A comprehensive analysis of academic library research. *The Journal of Academic Librarianship, 41*, 123–129.

Neuendorf, K. A. (2002). *The content analysis guidebook.* Thousand Oaks, CA: Sage.

Ngulube, P. (2015). Trends in research methodological procedures used in knowledge management studies. *African Journal of Library, Archives and Information Science, 25*(2), 125–143.

Palvia, P., Leary, D., Mao, E., Midha, V., Pinjani, P., & Salam, A. F. (2004). Research methodologies in MIS: An update. *Communications of the Association for Information Systems, 14*, 526–542.

Palvia, P., Mao, E., Salam, A. F., & Soliman, K. S. (2003). Management information systems research: What's there in a methodology. *Communications of the Association for Information Systems, 11*, 289–309.

Palvia, P., Pinjani, P., & Sibley, E. J. (2007). Editorial: A profile of information systems research published in the information and management. *Information Management, 44*(1), 1–11.

Park, S. (2004). The study of research methods in LIS education: Issues in Korean and U.S.

universities. *Library & Information Science Research, 26*, 501 − 510.

Peritz, B. C. (1977). *Research in library science as reflected in the core journals of the profession: A quantitative analysis (1950–1975)* (Unpublished doctoral dissertation) Berkeley, CA: University of California.

Powell, R. R. (1999). Recent trends in research: A methodological essay. *Library & Information Science Research, 21*, 91–119.

Spradley, J. P. (1980). *Participant observation.* New York: Holt, Rinehart and Winston.

Thelwall, M. (2008). Bibliometrics to webometrics. *Journal of Information Science, 34*(4), 605–621.

Tuomaala, O., Järvelin, K., & Vakkari, P. (2014). Evolution of library and information science, 1965-2005: Content analysis of journal articles. *Journal of the Association for Information Science & Technology, 65*, 1446–1462.

Turcios, M. E., Agarwal, N. K., & Watkins, L. (2014). How much of library and information science literature qualifies as research? *Journal of Academic Librarianship, 40*, 473–479.

White, M. D., & Marsh, E. (2006). Content analysis: A flexible methodology. *Library Trends, 55*, 22–45.

Williams, J. F., II, & Winston, M. D. (2003). Leadership competencies and the importance of research methods and statistical analysis in decision making and research and publication: A study of citation pattern. *Library & Information Science Research, 25*, 387–402.

Heting Chu is a professor in the Palmer School of Library and Information Science at Long Island University, New York. She obtained her PhD degree in information studies from Drexel University, Philadelphia, Pennsylvania, in 1991. Her teaching and research interests include the use of information technology in library and information science, especially in the areas of information representation and retrieval, library and information science education, research methods, and scientific communication. Dr. Chu has published over 40 research articles in journals such as *Journal of Academic Librarianship*, *Journal of Documentation*, *Journal of Education for Library and Information Science*, *Journal of the Association for Information Science and Technology*, and *Library and Information Science Research*. Her book *Information Representation and Retrieval in the Digital Age* (2nd ed., Information Today, 2010) has been translated into Chinese, Korean, and Arabic, and was also published in India. She is working on a book manuscript titled *Research Methods and Design: An Interdisciplinary Approach*.

Qing Ke is a professor in the School of Information Management at Nanjing University, China. She holds a PhD in information management from Nanjing University and a master's degree from Wuhan University, China. She has published more than 30 research articles in library and information science journals in Chinese and English. Her current research concerns research methods, information behavior, and human computer interaction.