Evaluations on social network analysis (SNA) research in Mainland China: A critical assessment of journal literatures

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Abstract Social network analysis (SNA) has been introduced to Mainland China since the end of last century. It is often stated that SNA research has experienced rapid growth in China over these years, but few studies have been conducted to prove the statement. This paper aims at exploring the research status and development of SNA in China by a critical assessment of journal articles. Our findings show that SNA is an evolving and diversified research area which has rich themes and topics, and can be applied to those studies on different levels, context and disciplines, and attract researchers and scholars from various fields and domains. In addition, the information community (Library & Information Science and Information Systems) plays a leading role in the SNA related researches. The paper also points out the research on SNA in China has some limitations, so it proposes several implications for the future development of SNA research from perspectives of information science.

Keywords Social network analysis(SNA), Bibliometric analysis, Classification scheme, Research evaluation, Mainland China, iSchools

1 Introduction

Social networks are nodes of individuals, groups, organizations, and related systems that tie in one or more types of interdependencies, which included kinship, social contacts, financial exchanges, shared visions, membership in organizations, and group participation events, among numerous other aspects of human relationships[1]. Social network analysis (SNA thereinafter) focuses on the structure of relationships, ranging from casual acquaintance to close bonds, and measures formal or informal relationships to understand the connection and structure of numerous nodes[2]. Freeman defined SNA as an organized paradigm for research, which consist of 4 features[3]: 1) it is “motivated by a structural intuition” and focused on ties between

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actors rather than on attributes of actors; 2) it is based on systematic collection of data about those ties; 3) it relies on graphics; and 4) it depends on mathematical or computational tools to make sense of the welter of information about all those ties.

Today, SNA has its own professional association, annual conference, and academic journals. The International Network for Social Network Analysts (INSNA), founded by Barry Wellman in 1977, has a high reputation worldwide now. While sociologists form a plurality of its members, the group also includes researchers from other disciplines, such as Communications, Computer Science, Library and Information Science, Management Information Systems, Economics, Psychology, etc. Additionally, INSNA’s annual conference attracts more than 500 people each year. It is worthy of note that there are three peer-reviewed journals, Social Networks, Connections and Journal of Social Structure that publish social network research exclusively. SNA also appears in other kinds of academic journals, such as American Sociological Review, Administrative Science Quarterly, Human Organization, Scientometrics, Journal of Information Science, and Management Science, etc.

Since the 1980s, the concept of SNA has been introduced to mainland China, but it mainly appeared in Sociology. For instance, in 1986, Tianjin Academy of Social Sciences collaborated with Columbia University in a research project named “Career, lifestyle and social network of urban residents in Tianjin”. An early journal paper about SNA was published in 1995 by Fang, who introduced the preliminary concepts of SNA[4]. Yuan incorporated SNA as a research method in his textbook Social Research Method[5]. Gradually, researchers in mainland China started to pay attention to SNA and its applications. Two books have to be mentioned here due to their significant contribution to the application of SNA[6,7]. Furthermore, Liu also translated John Scott's handouts on SNA into Chinese and published a monograph based on SNA method[8]. Moreover, owing to the establishment of Committee of Social Network affiliated with Chinese Sociological Association, SNA experienced a rapid development in mainland China. Since then, the committee organized regular seminars on SNA related topics and themes.

This paper aims at exploring the research progress of SNA in mainland China by a critical assessment of journal articles. Through selecting papers from Chinese Academic Journals of Full-text Database (CAJFD)1, a literature survey is conducted by employing different methods to get a generalized view about SNA research in mainland China from both research objectives and approach perspectives. By means of two dominant approaches in literature review, i.e. bibliometric analysis and classification scheme coding, our research tapped into various units including the

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1 http://211.151.93.11/Kns55/brief/result.aspx?dbPrefix=CJSSF
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subjective and objective sections. Compared with other qualitative literature reviews, this study reflected more multi-lens critical thinking in a quantitative way, so it is an early attempt for systematically illustrating the holistic picture of SNA research in mainland China.

2 Data collection

CAJFD, the largest full-text interdisciplinary Chinese journals database, was used to retrieve literatures on SNA. It is the largest Chinese academic database in the world with more than 31 million articles, thus it is an appropriate database for our study.

Although it would be desirable to select a group of relevant academic journals before doing the article selection, there are some difficulties. Firstly, there are no academic journals specifically on SNA in China as yet, hence such studies were scattered in different kinds of journals; Secondly, the research work of SNA has a diverse characteristic, our study should not be confined in any of a specific discipline. Therefore, we chose the “Title” and “Keywords” as our perimeter of search fields, given the fact that SNA may appear in either or both of them. In addition, we also have added some related search terms in order to retrieve more relevant articles. It is worth noting that the translation of SNA as a terminology from English to Chinese has two principal versions, i.e. “shehui wangluo fenxi” and “renji wangluo fenxi”, also with some other trivial expressions like “zaixian wangluo fenxi”, “shehui zhichi wangluo fenxi” etc. This was due to the different understanding from experts of various disciplines when they introduced the SNA to mainland China at the early stage. Accordingly, we used the multiple terms related with SNA, either in Chinese or in English, to collect the potential articles in the subject.

We employed a two-stage process for paper selection. Firstly, we formed a pool of all collected SNA research articles. The editorial introductions, book reviews, dissertation abstracts, letters, research commentary and announcements were removed from those candidate articles in order to focus on the contents of the research papers. Meanwhile, those articles without any keywords and abstracts were excluded from our study, too. As a result, we identified 383 articles to form the first pool. Secondly, we evaluated each paper for its relevance to SNA. We excluded those articles that might contain SNA terms in the title or keywords, but essentially have a non-SNA focus. For example, the acronym of “System of National Accounts” and “System Network Architecture” also corresponds to SNA, but they have totally different meanings. We also excluded papers if they were about pure introduction of social network or description without any focus on the theory-building, methods or applications of SNA. Finally, a total of 240 articles were included for our further analysis.
3 Research approaches

There are generally three approaches for reviewing a discipline or a research field. The first is to use bibliometric analysis to discover the research progress and frontier. Some methodologies are frequently used, such as citation analysis\(^9\), content analysis\(^10\), co-word analysis\(^11\) and cluster analysis\(^12\), etc. The second is to use classification schemes to code interesting elements such as research topics, methods, levels of analysis and reference discipline of published articles in the field\(^13–15\). The third is to use surveys or interviews to collect researchers’ perceptions\(^16,17\). In this study we considered a combination of the first and second approach discussed above, i.e. the bibliometric analysis and classification-based approach. Although there are many widely used classification schemes in information related studies to meet the needs of different facets, we cannot apply those schemes directly since SNA has some unique characteristics. Therefore, some modifications are used to better our schemes. In the coding stage, we allowed a paper to be assigned to multiple categories in some facets, such as applied discipline and research method, in order to keep the level of analysis fixed for the rigorousness of the SNA study.

A coding worksheet in Excel was used to record data extracted from the articles in order to provide uniformity, consistency, and completeness of the research. Two authors of this study independently evaluated and coded a subset of the papers to examine the classification schemes. After several iterations, we finalized all classification schemes and independently coded some papers. Then we discussed with the third author to resolve those disagreements and went ahead with the next small set of papers until finished. During the process, we carefully recorded coding results and disagreements, along with the resolutions for any disputes. Moreover, we evaluated the inter-rater reliability of the coding results by Cohen’s kappa coefficient, and the results showed that the kappa coefficients across all categories were highly significant. The kappa values for the three categories range from 0.844 to 0.915, all exceeding the 0.70 standard recommended\(^18\). Before further analyses, we discussed all disagreements and achieved a consensus.

4 Data analysis

4.1 SNA articles published in Chinese journals

Fig. 1 depicts the yearly distribution of SNA publications in Chinese. Among 240 papers, the first paper was published in 1995, and there was a slow increase from 1995 to 2004. However, there was a marked number increase since 2005 with an over five-fold rise from 2005 \((n=15)\) to 2009 \((n=83)\). We recognized that the number in 2009 might even be larger than 83 because of the lag by the index of CAJFD.
The above graph demonstrates that although SNA has been introduced to mainland China since the last decade, it was actually in the year between 2004–2005 that SNA started its inroad in the world of China’s academic publishing. Interestingly, that period of timeframe was also the turning point from Web 1.0 to Web 2.0, which was advocated by Tim O’Reilly and then flourished\cite{19}. Until now, we are not sure if it was a coincidence or some potential connection between SNA development and Web 2.0. However, we believe that the issuance of two books with regard to the introduction of SNA by Liu\cite{7} and Luo\cite{8} in 2004 and 2005 may play a critical role in popularizing and catalyzing the research of SNA in China.

4.2 The most prolific Chinese journals carrying SNA papers

Among the 119 journals that published a total number of 240 articles on SNA by Chinese authors that we surveyed, 20 authors (16.80%) published more than 3 articles for each, which account for 53.33% ($n=128$) of total publications in this subject field of SNA. There are also another 13 journals that each published 2 papers and the rest of a large sum of 86 journals only published 1 paper each. This statistics indicates a strong discrete distribution and decentralized tendency (similar with power-law principle), i.e. only a few journals contribute more than half of the publications while the rest just contribute a small number. As shown in Table 1, Library and Information Service is on the top of the list, which accounts for 6.7% of the total papers related to SNA ($n=16$). Journal of the China Society for Scientific and Technical Information, a prestigious peer reviewed journal in information studies of mainland China, is in the second position with 5.4% of total such
Another eight journals published articles on this subject varied from 6 (2.5%) to 10 (4.2%). An interesting finding is that among the top 10 journals which published SNA papers, 6 of them are information studies related journals. This indicates that the latter plays a very active role in presenting trends, new issues, and innovative ideas regarding to SNA.

Table 1  Ranking order of Chinese journals that have a high frequency of SNA subjects

<table>
<thead>
<tr>
<th>Rank</th>
<th>Journal</th>
<th>Count</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Library and Information Service</td>
<td>16</td>
<td>6.7</td>
</tr>
<tr>
<td>#2</td>
<td>Journal of the China Society for Scientific and Technical Information</td>
<td>13</td>
<td>5.4</td>
</tr>
<tr>
<td>#3</td>
<td>Information Science</td>
<td>10</td>
<td>4.2</td>
</tr>
<tr>
<td>#3</td>
<td>Journal of Intelligence</td>
<td>10</td>
<td>4.2</td>
</tr>
<tr>
<td>#4</td>
<td>Science of Science and Management of Science &amp; Technology</td>
<td>8</td>
<td>3.3</td>
</tr>
<tr>
<td>#5</td>
<td>Open Education Research</td>
<td>7</td>
<td>2.9</td>
</tr>
<tr>
<td>#6</td>
<td>Studies in Science</td>
<td>6</td>
<td>2.5</td>
</tr>
<tr>
<td>#6</td>
<td>Information Studies: Theory &amp; Application</td>
<td>6</td>
<td>2.5</td>
</tr>
<tr>
<td>#6</td>
<td>Sociological Studies</td>
<td>6</td>
<td>2.5</td>
</tr>
<tr>
<td>#6</td>
<td>New Technology of Library and Information Service</td>
<td>6</td>
<td>2.5</td>
</tr>
</tbody>
</table>

4.3 The most prolific authors on SNA

According to our statistics, a total of 416 different authors contributed to the SNA publications among 240 of our surveyed articles. Among them, 26.25% were by single authors, 38.33% were by two authors (which form the largest category), 22.92% were by three authors and 12.50% were by four authors or more. This outcome shows an extensive collaboration in this field. Meanwhile, we have to keep in mind that the ranking of productivity of these contributed authors is always time-dependent and source-dependent. Thus our study is a reflection of those active authors whose publication(s) are confined to a specific timeframe.

There are three popular methods that are often used to identify prolific authors in a particular discipline or research topic, namely, 1) normal ranking, 2) adjusted ranking, and 3) straight ranking[13,20]. Normal ranking is based on the assumption that all authors play an equal role in terms of publishing a paper. Thus every co-author of an article receives one point equally. Adjusted ranking method assumes that the contribution of a co-author is deemed to be greater if the writing project involves fewer other major co-authors. Hence each co-author of a paper receives only a fraction of one point determined by the number of co-authors. For example, each of the two co-authors of a paper receives half a point, and each of the three co-authors of a paper receives one third point. Straight ranking method is based on the belief that the first author is solely responsible for idea creation, thus is the only person to receive credit point. However, it should be noted that the straight ranking method is limited in measuring the nature of collaboration in scientific publications,
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which in turn may somewhat undermine the author’s motivation for collaborative undertakings.

In this paper, we designed a simple algorithm to substitute for straight ranking, and name it as “weight adjusted ranking.” This method highlights the solo contribution by the only author responsible for producing a paper and assigns 1.5 point for it. For those co-authored papers, the credit points given to each author are decreased by a scheme of descending order, i.e. Grade \( (n) = \frac{1}{n} \). For example, if a paper has three authors, the first author may receive 1 point, the second author will get 0.5 point, and the third author can receive 1/3 point. Therefore, we used a combined formula consisting of the features of normal ranking, adjusted ranking and weight adjusted ranking together to provide an author’s true ranking. Table 2 lists the three rankings for these authors. As can be seen from the table, the top 6 researchers, Lu Wang, Xiaowei Wu, Qinghua Zhu, Zeyuan Liu, Jun Liu and Wenhong Zhang also, to a large extent, overlap with one another when applying the three different ranking methods.

Table 2  Ranking order for the most prolific authors on SNA subjects

<table>
<thead>
<tr>
<th>NR</th>
<th>NC</th>
<th>Authors</th>
<th>AR</th>
<th>AC</th>
<th>Authors</th>
<th>WAR</th>
<th>WAC</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>7</td>
<td>Lu Wang, Zeyuan Liu</td>
<td>#1</td>
<td>5.25</td>
<td>Lu Wang</td>
<td>#1</td>
<td>7.33</td>
<td>Lu Wang</td>
</tr>
<tr>
<td>#2</td>
<td>6</td>
<td>Qinghua Zhu</td>
<td>#2</td>
<td>3</td>
<td>Qinghua Zhu, Xiaowei Wu, Jun Liu</td>
<td>#2</td>
<td>6</td>
<td>Xiaowei Wu</td>
</tr>
<tr>
<td>#3</td>
<td>5</td>
<td>Xiaowei Wu</td>
<td>#3</td>
<td>4.5</td>
<td>Jun Liu, Wenhong Zhang</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#4</td>
<td>4</td>
<td>Wenhong Zhang, Tiehui Qin, Xianwen Wang, Yunlin Wang, Daohan Zhou</td>
<td>#3</td>
<td>2.58</td>
<td>Zeyuan Liu</td>
<td>#4</td>
<td>4</td>
<td>Xiaoning Wang, Jianmin Tang, Tiehui Qin</td>
</tr>
<tr>
<td>#5</td>
<td>3</td>
<td>Jun Liu, Dongge Zhang, Xiaoning Wang, Haiyan Hou, Jianmin Tang, Hongjiang Yue, Shuchun Chang, Cunfu Ye, Ding Li, Yuefen Wang, Yong Hu, Guangming Hou, Xiangdong Chen, Ning Cai, Junping Qiu, Changhuo Bao, Xindong Ye</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#4</td>
<td>2.5</td>
<td>Xiaoning Wang</td>
<td>#5</td>
<td>3.83</td>
<td>Zeyuan Liu</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#5</td>
<td>2.33</td>
<td>Wenhong Zhang</td>
<td>#6</td>
<td>3.5</td>
<td>Qinghua Zhu, Hongjiang Yue, Yong Hu, Xiangdong Chen, Changhuo Bao</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#6</td>
<td>2.25</td>
<td>Jianmin Tang</td>
<td>#7</td>
<td>2</td>
<td>Hongjiang Yue, Yong Hu</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: NR, Normal ranking; NC, normal counting; AR, adjusted ranking; AC, adjusted counting; WAR, weight adjusted ranking; WAC, weight adjusted counting.
4.4 Institutional affiliations of prolific SNA researchers

SNA related studies have attracted many researchers from a great number of institutions. According to our statistics, 416 authors came from 100 institutions (at the time of publication). Among them, the top 5 institutions in the ranking (7%) accounted for 30% ($n=72$) of the total publications. It is interesting to note that half of the institutions only contribute one paper each, which demonstrates a marked imbalance in terms of contribution among different institutions. We are also surprised to find that although the cooperation and collaboration are very prevalent among different authors, that type of collaboration seems less visible at the institutional level. Only 9 articles (3.75%) were co-authored by different institutions. Therefore, we did not use the ranking methods raised above to assess the most productive institutions but rather adopted a simple way in calculating the numbers of publications from each institution. Table 3 presents the most productive institutions on SNA research within their certain pertinent disciplinary units, which also takes into account of those prolific authors enlisted in Table 2. Finally, another interesting finding is that all of the seven most productive institutions on SNA research listed in the table (the top ranking 5 institutions) are also the most reputable universities and academies in mainland China.

4.5 Most studied research topics on SNA

To date, we have not retrieved any topic classification scheme specifically designed for the SNA framework, thus in this paper, we adopted the co-word analysis as the research method to detect the principal research topics in this field. The main feature of co-word analysis is that it reveals patterns and trends in a specific discipline by measuring the association strengths in terms of representatives of relevant articles published in this discipline. Many researchers have used co-word analysis as an important method to explore research topics, structures and trends in different fields[11,21,22].

Generally, there are three steps for co-word analysis: data collection, data standardization and data mapping[22]. In data collection stage, we chose the keywords added by the CAJFD database indexers, and also extracted keywords from the titles and abstracts of the corresponding articles manually. The average number of keywords per article is found to be 4.28, and the range of keywords for each article varies from 3 to 9. In data standardization stage, the first and most important work is data cleaning. Among 240 articles, some related concepts are represented by different keywords, thus further work is needed to make them consistent, unified and unambiguous.

For example, we used e-learning to cover all its synonyms such as electronic learning, distant learning and online learning; we used blog to replace blogging
and *blogger* in order to eliminate ambiguity; and we use *culture* to broaden terms like *culture elements, culture styles and culture diversity*, and so on. After that, a total number of 542 unique keywords were collected, and then a further step is taken to exclude those words with frequency less than 3 in our list. We also excluded “SNA” and “social network analysis” from our keywords pool for their absolute fitness to this research topic. Finally, 55 keywords with frequency more than 3 were chosen as the research sample for co-word analysis.

We formed a co-occurrence matrix of 55*55 keywords, and the higher co-occurrence frequency of the two words means the closer relationship between them. The matrix was then transformed into a correlation matrix by Pearson’s correlation coefficient. In data mapping stage, the most commonly used methods are clustering techniques and multi-dimensional scaling (MDS). We chose hierarchical clustering techniques with Ward’s method and Phi-square Measurement by SPSS 13.0 for its convenience in computing. The raw data 55*55 matrix was recalculated (Pearson correlation coefficient) in order to find proximity on the basis of the 55-vector. The
similarity between two words was calculated on the basis of all co-occurrence frequency that these two words have with other items in the same matrix. So the words with high Pearson correlation coefficient are clustered together in the tree. Fig. 2 shows that these 55 keywords can be divided into 8 clusters. Each cluster is labeled according to the most frequent keywords appearing in the clusters and the common characteristics revealed by the keywords and those papers they tagged.

Bibliometrics & Scientometrics includes the research topics such as citation analysis, co-author analysis, scientific collaboration, knowledge map, technology forecasting, and discipline evolution and development, etc. Social structure, relationship and culture includes the research topics such as social class status, social structure, social capital and support network, culture and social norm, life condition in urban and rural area, etc. E-learning covers topics on cyber classroom, distant learning, collaborative learning, IT in education, and so on. Theory &

![Fig. 2](image)

**Fig. 2** Most studied research topics on SNA.
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The foundation of SNA focuses on complex network, structure hole, core-periphery model, centrality and weighted network, social capital theory, weak and strong ties, etc. Competitive intelligence covers topics on business intelligence, information retrieval, competitive intelligence systems, human network and relationship, P2P, patent network, and so on. Information & knowledge management includes topics on information and knowledge sharing, knowledge communication and transfer, teamwork in/between organizations, technology innovation, information consultation, and user behavior study, etc. Community informatics & new media center on virtual community, online community, computer-mediated participation, communication and collaboration, link analysis, web mining, and new media studies, etc. Industrial economy & structure includes the research topics related with enterprise clusters, industrial cluster, strategic alliance, channel evolution and management, interorganizational cooperation, and so on. Therefore, the 8 clusters along with their sub-domains explain the hot SNA research topics in mainland China.

Although a research paper may cover several topics, we supposed that each paper should have a primary research theme, thus we only assign the most related topic for each paper during our coding process (Disagreement on what is the most pertinent theme was settled down after several discussions by all the authors). Table 4 summarizes the occurrence frequencies for each topic over these years. We find that different research topics have different evolution trends. Bibliometrics & scientometrics started very late (nearly in 2006) yet increased at a dramatic speed.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Evolution trends for the research topics during 1995–2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1995</td>
</tr>
<tr>
<td>Bibliometrics, scientometrics</td>
<td>0</td>
</tr>
<tr>
<td>Social structure, relationship &amp; culture</td>
<td>0</td>
</tr>
<tr>
<td>E-learning</td>
<td>1</td>
</tr>
<tr>
<td>Theory &amp; foundation of SNA</td>
<td>1</td>
</tr>
<tr>
<td>Competitive intelligence</td>
<td>0</td>
</tr>
<tr>
<td>Information &amp; knowledge management</td>
<td>0</td>
</tr>
<tr>
<td>Community informatics &amp; new media</td>
<td>0</td>
</tr>
<tr>
<td>Industrial economy &amp; structure</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
</tr>
</tbody>
</table>

National Science Library,
Chinese Academy of Sciences

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in number, which accounts for 22.5% of the total papers and became a hot research topic in SNA, while Social structure, relationship & culture started earlier in 1999 yet had not aroused wide attention. Additionally, theory & foundation of SNA and information & knowledge management experienced a steadily increase while competitive intelligence and industrial economy & structure fluctuated during these years.

4.6 The levels of analysis on SNA

The notion of level of analysis has been introduced by Bariff and Ginzberg in an attempt to understand behavioral IS research\[23\]. They classified the behavioral IS research into individuals, group, organizational, and inter-organizational issues. Vessey et al. defined the level of analysis as society, profession, inter-organizational context, organizational context, project, group/team, individual, abstract concept, computing system and computing element\[14\]. Zhang and Li studied the intellectual development of Human-Computer interaction research, and they placed great emphasis on individual and group level of analysis\[15\]. In our study, we identified the level of analysis by examining relevant sections of the articles, especially the abstract, introduction and data collection (if have).

All authors discussed together to finalize our own classification scheme for the level of analysis on SNA. Our scheme was adapted from Vessey’s and Zhang & Li’s works, which indicates good reliability and validity in empirical studies.

Among them, abstract, concept/theoretical framework level focuses on the construction of theoretical foundation and basic concept of SNA itself as well as the integration with any other theories. Professional level captures papers that take SNA as an effective research method or analysis tool to study some specific discipline or subject, thus contributing to the knowledge accumulation and recognition of any academic research disciplines or communities. System level pays attention to the model construction, lab simulation, system planning and developing, in order to build and develop social network sites, social software platforms and other systems with social network services. Group/team level captures papers whose focus is on specific group or team, no matter whether it is real or virtual. Those studies highlight the structure and organization of a group or team. Organizational level focuses on connections and structures in organizations or institutions, such as enterprises, non-profit institutions, or between organizations, such as industries and alliance. SNA can help the researchers to investigate the dynamic relationships in and between the organizations. Social level captures papers that examine SNA issues or use SNA as a method to study social structure, class status, social capitals, and people’s living condition in different strata at regional, national, or international levels that have no organizational context.
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Fig. 3 shows that among 240 papers, 76 papers (32%) are on the professional level, 53 papers (22%) are on the organizational (inner/inter) level, the following is abstract concept/theoretical framework level (16%), social level (13%), group/team level (11%) and system level (6%).

Table 5 summarizes the changes on the level of analysis over these years. Frequency of level of analysis illustrates that most of the levels experienced an increasing tendency with minor fluctuation except the system level. It also shows that in the initial stage, SNA was firstly studied on abstract concept/theoretical framework level and social level in mainland China, and then it flourished and diffused to other levels. This is consistent with the conventional wisdom that SNA was introduced to mainland China by sociologists. Meanwhile, it is worth noting that the papers on professional level had a marked increase since 2006, which indicates that SNA was frequently applied as a research method to study some other disciplines or subjects in these years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Abstract, concept/theoretical framework level</th>
<th>Social level</th>
<th>Group/team level</th>
<th>System level</th>
<th>Professional level</th>
<th>Organizational (inner/inter) level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1999</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2003</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2004</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>3</td>
<td>6</td>
<td>2</td>
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<td>1</td>
</tr>
<tr>
<td>2006</td>
<td>3</td>
<td>5</td>
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<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>5</td>
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</tr>
<tr>
<td>2008</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>2009</td>
<td>14</td>
<td>8</td>
<td>13</td>
<td>1</td>
<td>34</td>
<td>13</td>
</tr>
</tbody>
</table>
4.7 The applied disciplines of SNA

The previous studies usually focused on the reference discipline or contributing discipline for a research field\cite{14,15}. Their classifications referred to the disciplines that support or contribute to the development of some research theories, conceptual models, and hypotheses, etc. However, in this paper we view the SNA as both a research object and a method which can be applied to different disciplines and make contributions. To this end, it is more interesting to explore the applied disciplines of SNA. Our study attempted to reveal which disciplines are interested in SNA related studies or frequently employ SNA as an important research method. Therefore, we need a classification scheme that is neutral yet represents all possible disciplines so that we could examine the interdisciplinary nature of the SNA studies.

The extant literatures used various classification schemes in terms of the reference discipline\cite{14,15}. In this paper we aimed to study the research status of SNA in mainland China, thus we would like to choose a classification scheme more localization-oriented which can fit well with our aim and scope. Finally, we adopted the discipline classification codes developed by Ministry of Education, China. During our coding process, we only focused on the disciplinary level, not on the division level (too broad) or subject level (too narrow), yet we used the subjects to justify a discipline when coding any particular paper. Meanwhile, we also referred to the category number provided by each paper to help us making a decision. Keep in mind that each paper was not limited to one applied discipline to ensure that the diversity can be well demonstrated in this study.

Fig. 4 illustrates that 10 disciplines was detected after our classification coding. Among them, 87 articles are labeled with library & information science discipline, 62 articles are classified to science of business administration discipline, and 42 articles are included into management & systems science discipline. The followed

![Fig. 4 Applied disciplines of SNA.](image-url)
are education science (29), sociology (29), computer science & technology (23), economics (23), communication (18), philosophy (10) and science of physical culture & sports (3). From the radar map we can find that the most applied disciplines were library & information science, science of business administration, and management & systems science, which had a significant advantage over the other disciplines.

Fig. 5 depicts the changes on the applied disciplines over these years. All of the ten disciplines in our study show an ascending trend with minor fluctuation. We can see that Library & Information Science had the most marked growth rate, which is fairly consistent with our finding on the most applied disciplines. We also noticed that most of the applied disciplines had been going through a significant increase since 2005, which is also a milestone for SNA to be widely studied and employed in mainland China.

Fig. 5 Changing trends of the applied disciplines.

4.8 Cross-facet analysis between applied disciplines and level of analysis

Cross-facet analysis is used to examine the degree of relationships or connections between different facets, which can provide interesting insights for the research topics[24]. Table 6 shows the frequencies of a particular applied discipline appearing in the same paper with a particular level of analysis. According to our statistics, the discipline of library & information science was very active in studying the level of abstract concept/theoretical framework, group/team, professional, and organizational, especially on professional level, and more than half of the articles were related with library & information science. It is also interesting to find that the three applied disciplines, i.e. sociology, computer science & technology, and science of business administration contributed most to the social level, system level and organizational
level, respectively. Additionally, the results show that all the papers published in science of physical culture & sports discipline were conducted under group/team level.

Table 6 Cross-facet analysis between applied disciplines and level of analysis

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Abstract concept/ theoretical framework level</th>
<th>Social level</th>
<th>Group/team level</th>
<th>System level</th>
<th>Professional level</th>
<th>Organizational (inner/inter) level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philosophy</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Economics</td>
<td>3</td>
<td>9</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Sociology</td>
<td>8</td>
<td>18</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Education science</td>
<td>4</td>
<td>4</td>
<td>7</td>
<td>0</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Science of physical culture &amp; sports</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Communication</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Computer science &amp; technology</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Management &amp; systems science</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td>6</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Science of business administration</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>11</td>
<td>34</td>
</tr>
<tr>
<td>Library &amp; information science</td>
<td>11</td>
<td>2</td>
<td>12</td>
<td>1</td>
<td>45</td>
<td>16</td>
</tr>
</tbody>
</table>

4.9 Research methods related with SNA

In this study, we used Alavi and Carlson’s classification scheme\cite{25} for research method owing to its comprehensiveness and wide acceptance\cite{26}. Our framework distinguished between non-empirical and empirical papers at the highest level. The former captures the essence of studies relying on observation and illustration; while the latter is primarily based on ideas, data, speculation, and verification. However, we did not subdivide the non-empirical approaches because of the difficulties in differentiating those methods from the papers. Meanwhile, we made some modifications to Alavi and Carlson’s framework on empirical methods by added individual-based “Interview” and group-based “Focus Group” to the scheme, which have also been validated by Zhang and Li’s work\cite{15}.

Among the empirical studies, due to the dual roles of SNA as both a research object and a method, we attempted to explore several questions like: 1) how many papers used SNA as sole method; 2) how many papers adopted other methods to study SNA as a research object; and 3) how many papers used SNA along with other methods together to study SNA or other topics? As shown in Table 7, among 240 articles, 90 are non-empirical studies while 150 are empirical studies. We also extracted several empirical methods according to our coding. Besides SNA itself as a method which has been used for 136 times, the other three mostly used methods are secondary data (62), survey (30) and case study (21). Moreover, 30 papers took SNA as the solo method in their studies, 14 papers used other methods without SNA
Evaluations on social network analysis (SNA) research in Mainland China: A critical assessment of journal literatures

(method) to study issues related with SNA (object), while 106 papers co-used SNA (method) and other methods.

Table 7 Overview of research methods related with SNA

<table>
<thead>
<tr>
<th>Research method</th>
<th>Articles</th>
<th>Frequency (%)</th>
<th>Methods used</th>
</tr>
</thead>
<tbody>
<tr>
<td>None-empirical</td>
<td>90</td>
<td>37.5</td>
<td>—</td>
</tr>
<tr>
<td>Empirical*</td>
<td></td>
<td></td>
<td>SNA</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>12.5</td>
<td>Others</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>5.83</td>
<td></td>
</tr>
<tr>
<td></td>
<td>106</td>
<td>44.17</td>
<td>SNA &amp; others</td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

*Note: Except SNA, the mostly used empirical methods are secondary data (62), survey (30), case study (21), focus group (14), lab experiment (13), interview (11), and development of instruments (9).

Although we have examined the research methods mentioned in our scheme, we still intend to investigate a much clearer picture on the relationship between SNA (method) and other methods, which are more specific and instructive for our research aims. Therefore, we read the papers one by one and extracted method-related information mainly from several sections of the articles, such as title, keywords, abstract, research method and data analysis, and then we used the UNICET to draw the connection map between different methods and analysis tools covered in our paper pool. Fig. 6 illustrates the overview of collected methods from

![Diagram](image-url)
the papers in our study. In the method network graph, we can find that SNA itself was the most frequently used approach to study SNA issues or other topics, meanwhile some quantitative methods such as citation analysis, co-occurrence analysis, and cluster analysis, etc., and some qualitative methods such as questionnaire survey, interview, and case study, etc., are closely related with SNA and each other, which indicates that those methods or analysis tools are often co-used with SNA method.

5 Discussion

5.1 Generalized view of SNA research in mainland China

Fig. 7 illustrates the related components, dimensions and issues that are pertinent to our study.

The basic component of SNA can be classified to theory, methodology and application. There are mainly two kinds of theories regarding the papers we have reviewed. Formalist theories are primarily concerned with describing the
mathematical form of social networks, while structuralist theories are concerned with how patterns of relations and various structures can influence the interaction and collaboration between different nodes. In methodology section, SNA can be solely used or collaborated with other methods in terms of the research topics. Interestingly, some papers also used other methods to study SNA and its related topics. On the temporal dimension, we construct a four-stage evolution for the development of SNA according to the literature review and our speculation.

We find that in the initial stage SNA was usually studied as a research object, and it was actually in the year of 2005 that SNA started its inroad in the world of China’s academic publishing (the second stage), in which many researchers gradually recognized the value of SNA as a research method. We define the third stage of SNA as the integrative one, which will place more emphasis on the contribution to the theories and applications of SNA, and those who adopt SNA will take a closer look at the rigorous and effectiveness of this method. In the fourth stage we assume that the innovation and diffusion will occur and SNA can fit much better with other disciplines and subjects. Now we are on the transition from the second stage to the third stage based on our findings from articles assessment. With respect to the application of SNA, it can be used in different contexts and studied in various levels. As shown in Fig. 7, we summarize three levels for this dimension, which is in accordance with our level of analysis mentioned above.

5.2 Limitations of SNA research in mainland China

The main limitation of SNA researches we observed in mainland China are methodological issues. Coincided with the criticism of social network research\cite{27}, most SNA studies in mainland China are also descriptive analyses of certain objects, which reflect that some researchers just use several SNA indices to reflect an existing phenomenon, and thus leading to very limited implications for both academic and practitioners. Furthermore, this kind of limitation can be divided into issues distributed in various stages of the whole research process. Firstly, SNA related studies generally do not propose any hypotheses in their research design, which may result in ambiguous research purposes and weaken the rigorous of the researches. Secondly, the reasons for SNA indices selection are usually not well explained, which may partially lead to some misuse of indices or drawing some improper conclusions. For example, density is found to be less useful in studying e-learning\cite{28}. Finally, researchers generally consider few time series in SNA studies, which may lead to shallow conclusions or boundary specification problems\cite{29}, such as the lack of dynamic and longitudinal lens.
5.3 Implications for future SNA research in mainland China from Information field perspective

A newly formed field over the past decades is the information field (or I-field) that is composed of a community of information-schools (or iSchools). The community brings together perspectives and approaches whose origins are in multiple and diverse fields\[^{30}\]. The iSchool community in mainland China pays great attention to SNA as both a research object and a method, and researchers from iSchools are well positioned to address the challenges and frontiers in SNA by integrating perspectives from various disciplines. From the results of our study, we attempt to propose three future directions of SNA research in mainland China from the lens of information related fields as follows.

5.3.1 Web 2.0, social software and recommendation system

With the advent of Web 2.0, numerous kinds of social software have attracted researcher’s attention. The relative single form of interactions in these social software applications make it easier for researchers to conduct SNA studies\[^{29}\]. By using SNA, researchers are able to generate networks that represent the relationship (e.g. friendship) and analyze the patterns reflected on the macro-level\[^{31}\], which is essential to understand users’ behavior\[^{32}\] and lay the foundation for the recommendation system. Online relationships can either be positive or negative, however, in academic fields, most of the current studies in mainland China focus on analyzing the positive links. If a researcher designs an algorithm without the consideration on differences among links, an improper item or person might be wrongly recommended to a user, thus leading to unpleasant user experience\[^{26}\]. Another key issue in social network based recommendation is the classification of users or items. Segmentation of users or items can be helpful in improving the accuracy and precision of recommendation system\[^{33}\]. To the end, SNA will play an important role in quantifying intuitive social notions (e.g. connectedness, centrality, etc) and providing methods for computing\[^{34}\]. Early attempts have been made to identify potential consumers through transaction network and categorize broadcast news by considering users’ social relationship network\[^{35}\].

5.3.2 Knowledge management in organization context

Promoting knowledge creation and sharing is always a challenge for both researchers and practitioners\[^{36}\]. Knowledge management, not only at intra-organization level but also at inter-organization level, has gained fruitful productions these years\[^{37}\]. In social network analysis, strong and weak tie are the two tires frequently used in KM studies, even the strong and weak tie hypothesis has become an established
paradigm\textsuperscript{[38]}\textsuperscript{[38],}. However, the debate on the relative value of strong versus weak ties has been fuelled due to the increasing studies that emphasize the importance of weak ties\textsuperscript{[39]}. Other structural elements, such as network position and network density, have also been noticed by researchers when conducting KM related studies\textsuperscript{[40],}. Comparing with the fruitful researches internationally, KM research in mainland China is still at its early stage. Research suggests that Chinese KM studies require suitable and local-oriented research model, rather than purely borrowing models from western countries\textsuperscript{[41],}. Particularly, cultural difference is an important factor on distinguish Chinese KM style from western\textsuperscript{[42],}. \textit{guanxi} (a kind of informal social networking in China) may have a profound influence on KM\textsuperscript{[43],}, indicating that SNA will probably play a significant role in conducting KM research in China. While strong ties can reflect cheap, trustworthy, and somewhat redundant but frequent interpersonal relationships\textsuperscript{[44],}, weak ties often indicate the bridging ability to other parties and the broader society\textsuperscript{[45],}.

5.3.3 ICT adoption and diffusion

Understanding user’s ICT adoption has proven to be one of the most challenging issues in information system research\textsuperscript{[46],}. Among various theories or model raised, motivational model\textsuperscript{[47],}, model of PC utilization\textsuperscript{[48],}, theory of planned behavior\textsuperscript{[49],}, TRA\textsuperscript{[50],}, TAM2\textsuperscript{[51] and UTAUT\textsuperscript{[52] all regard social factors as important variables that influence user’s adoption behavior. Some studies even use external variables, such as perceived critical mass\textsuperscript{[53],}, to improve the explaining power of the original model. However, from methodology perspective, this kind of research is usually based on survey, interview and case study, which is often limited by the sample size or biased distribution\textsuperscript{[54],}. According to our finding in methodology above, SNA can be well positioned to co-use with other methods. While SNA can provide computational indexes based on huge dataset, it is helpful for structural equation analysis (SEM) to mapping these indices into measuring constructs under certain circumstances. From theoretical perspective, SNA also provides indices to help researchers to develop new constructs reflecting network structure. Thus, it can be expected that more unbiased sample could be used for analyses in empirical studies, and more new constructs could be developed to integrating into models in the future.

6 Conclusions

SNA research has not a long history in mainland China. This study assesses the SNA related papers collected from CAJFD to demonstrate the research trajectory by bibliometric analysis and classification scheme. The findings show that SNA is an evolving and diverse research area which covers rich themes and topics, and can be
applied to various studies on different research levels, context and disciplines, and attract researchers and scholars from various fields and domains. Although we have illustrated a generalized view of SNA research in mainland China, our study laid a main focus on journal literatures, sources, such as conference proceedings, textbooks and monographs also reflecting the research development of SNA, might have been excluded. In addition, we have not taken those papers published in English or other languages by Chinese authors from mainland China into consideration. Finally, a comparative study on the research status and development of SNA from international perspectives may in turn help us to get a deeper understanding on SNA research and conduct more critical thinking in this area.

References
Evaluations on social network analysis (SNA) research in Mainland China: A critical assessment of journal literatures

Research Papers


(Copy editor: Ms. Jing CAO)